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Paleomagnetic study of red beds from the Triassic Newark-Gettysburg Basin: Chemical and thermal demagnetization techniques and magnetic stratigraphy.

Karen Lee Kluger

PALEOMAGNETIC STUDY OF RED BEDS FROM THE TRIASSIC NEWARK-GETTYSBURG BASIN: CHEMICAL AND THERMAL DEMAGNETIZATION TECHNIQUES AND MAGNETIC STRATIGRAPHY

by

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Professor in Charge

Chairman of Department

For Ed and Bettie

and Gary

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ABSTRACT

The remanent magnetization of red beds from the Late Triassic Newark-Gettysburg basin was investigated using thermal demagnetization and chemical leaching techniques. The red beds were well-behaved to the thermal treatment and at two sites yielded Late Triassic pole positions of 63.8° N, 107.3° E and 55.5° N, 115.1° E, in good agreement with other Late Triassic poles determined for North America. Magnetizations measured during chemical leaching showed three distinguishable behaviors that the thermal treatment obscured. Most significantly, as observed from the chemical leaching, some red beds appeared to contain both normal and reversed Triassic magnetizations. Magnetic stratigraphy developed from these red beds may be unreliable if this is the case.

Conventional stratigraphic sampling along with thermal demagnetization resulted in several previously unreported reversal intervals for this basin. A reversely magnetized interval of 65 m was found in the Brunswick Fm. By using a depositional rate for these red beds of 0.1 - 3 m/10^3 yr, this indicates that the field was primarily reversed for at least 21,700 - 650,000 yr. This is accurate only if these red

beds acquired magnetizations during or shortly after deposition. The lower and upper limits of the reversed interval were not determined at this site. Most likely, the reversal lasted even longer. This interval was also extended along strike to two other sites within 5 km of one another. In addition to this reversal in the Brunswick Fm, two shorter reversely magnetized intervals were also recorded in the Stockton Fm. All the reversely magnetized specimens measured from these Newark-Gettysburg basin red beds seemed to have acquired a hard overprint due to hematite that was not completely removable by the thermal treatment. For this reason, the pole calculated from the reversely magnetized samples had a slightly shallow latitude (55.5° N, 115.1° E) compared to other Late Triassic poles for North America. It is hoped these previously unrecorded reversely magnetized intervals will soon be correlated with other reversals within the basin, and eventually, with worldwide Mesozoic chronology.

INTRODUCTION

Purpose and statement of the problem

It is uncertain how red bed sequences have acquired their magnetic remanence. All red beds do not apparently have the same acquisition history. The most likely acquisition mechanisms for red beds are DRM, pDRM, and CRM (depositional, post-depositional, and chemical remanent magnetizations). Furthermore, acquisition of remanence may occur over tens or millions of years.

This study examines the magnetization of red beds in the Newark-Gettysburg basin, specifically the mechanism and timing of acquisition. The study was essentially undertaken for three purposes. These included, firstly, a comparison of demagnetization results between chemical leaching of iron oxides and thermal demagnetization. Secondly, a magnetostratigraphic control for these two demagnetization procedures was attempted. Finally, magnetic stratigraphic sections were developed to correlate this basin magnetically with other upper Triassic and lower Jurassic sequences.

By comparing chemical leaching results with thermal demagnetization results, it was hoped that an understanding would be reached of the magnetization process of the red beds of the Triassic Newark Group. The demagnetization procedures were thought to remove different components of magnetization that may have been acquired by different processes. If the chemical leaching revealed significant magnetization components which were not detected from thermal demagnetization, it would imply that the components were thermally stable.

These magnetization components could add vital information about the acquisition history of these red beds. Therefore the two demagnetization procedures were applied to the various lithologies of the Newark-Gettysburg basin.

Secondly, it was believed that by applying these two demagnetization procedures to a magnetostratigraphic control, variations noted could give time ranges needed to acquire remanence. The control consisted of a confined space of strata that probably represented a depositional time span of 110-3300 years. The suggestion was that if variations of intensities and polarities seemed great and non-uniform throughout the control, time ranges on the order of thousands of years could be expected for the magnetization process. In addition, multiple Triassic components of remanence were likely. Shorter acquisition periods would be expected to have less variations associated with them, and essentially one Triassic component of magnetization.

Finally, several magnetic stratigraphic sections were developed. Although much red bed chronology has been done, the Newark Group magnetostratigraphy of the Triassic Newark-Gettysburg basin remains underdeveloped. Paleopoles calculated from the basin have been essentially obtained from field directions of the igneous intrusives and extrusives found in the basin. Subsequently, quite a few reversed intervals remain unrecorded. These intervals could aid in correlating this basin's deposition and diagenesis with worldwide units of Triassic age.

Summarizing, the purposes of this red bed paleomagnetic study were three-fold.

1. By applying two demagnetization procedures (chemical leaching and thermal treatment) to different rock lithologies in the Triassic Newark Group of the Newark-Gettysburg basin, different components of magnetization may be seen that were previously obscured. A comparison of the two demagnetization histories might give an insight into how these red beds had acquired their magnetic remanence.

2. By noting variations in intensities and polarities during the two demagnetization histories in a magnetostratigraphic control, a time range could be placed on the acquisition process. The control consisted of a sequence that represented 110-3300 years of deposition.

3. To correlate units within this Triassic basin with worldwide Triassic units, several magnetostratigraphic sections were developed. The purpose was to locate reversely magnetized intervals. A question was asked for future studies to investigate: Do red bed samples thermally treated, validly record only one Triassic polarity, or are reversed polarities also recorded but obscured by the primary magnetic components? This question was based on the previous findings of the two demagnetization results.

Previous work

Previous studies in the Newark-Gettysburg Triassic basins have examined the remanent magnetization of both red beds and igneous units. The studies have generally had two different goals: to determine the Triassic pole position and to establish a magnetic polarity scale for Triassic time.

Several workers have done extensive paleomagnetic studies of the Newark-Gettysburg basin. Bowker (1960) was one of the first. He examined both Triassic sedimentary and igneous rock units of the entire eastern United States including the Newark-Gettysburg basin.

His igneous specimens were AF treated, whereas his sedimentary samples were not demagnetized.

Beck (1965, 1972) examined the field directions and determined Triassic pole position obtained from measurements of the igneous intrusives found in the Newark-Gettysburg basin. Treating his igneous specimens with AF demagnetization, he found normal polarities essentially.

Opdyke (1961, 1967) also did work in these basins. In one study, he examined the inclination error of red beds found juxtaposed to the Triassic Watchung lava flows in New Jersey. He compared the obtained red bed paleofield direction to the extrusive lava flow paleofield direction that had acquired remanence by TRM. His results showed no error in inclination of the red beds' magnetic remanence. Opdyke (1961) concluded that if DRM was the acquisition mechanism of the red beds, there was no error as the detrital grains were deposited and oriented in the ambient paleofield.

More recently, Martin (1975) studied a red bed sequence for the existence of reversals, and McIntosh (1976) studied both the red beds and igneous extrusives found within the Triassic Newark-Gettysburg basin to develop a polarity reversal sequence. Martin (1975) examined a 156 m core drilled in the New Oxford Formation near the southern border of the Gettysburg basin. His findings included a possible reversal interval of 3 m of stratigraphic section. He AF demagnetized his red bed samples. McIntosh (1976) examined sequences from both the Brunswick Formation and the Watchung flows of the Newark basin. He verified several reversely magnetized intervals in the Brunswick Fm. In addition, he found four or five possibly reversed intervals of 10 m or less in the third Watchung flow. McIntosh (1976) AF demagnetized his igneous samples and thermally treated his sedimentary specimens.

There have also been many paleomagnetic studies of Mesozoic rock units worldwide, particularly Triassic red beds and igneous units. Only the red bed studies will be mentioned. Collinson (1965) summarized results from many of the important studies.

Many significant red bed studies were conducted in the southwestern U.S. McMahon and Strangway (1968) summarized the magnetic chronology of the sequences of the Upper Paleozoic-Lower Mesozoic units from this area. Picard (1964) attempted to correlate units within the Triassic Chugwater Formation using paleomagnetic reversal chronology. Helsley (1969), Helsley and Steiner (1974), and Baag and Helsley (1974a and b) worked extensively in the Triassic Moenkopi Formation. Reeve and Helsley (1972) and Shoemaker and others, (1973) studied the Upper Triassic Chinle Formation. Reeve and Helsley (1972) noted that that paleontologically portions of the Chinle Formation and the Newark Group correlate. However, their reversal chronology did not correlate because of the reported lack of reversals in the Newark Group.

Much of the work mentioned above attempted to develop a magnetic chronology for these Mesozoic units consisting of normal and reversed sequences. In addition, in each of these studies, the nature of the remanent magnetization of these red beds was examined closely with respect to magnetic mineralogy, possible acquisition history of remanence, and general magnetic behavior through demagnetization procedures.

The results of the various studies have resulted in a Triassic pole position. In addition, by combining the reversal stratigraphy, several Mesozoic reversal sequences have been developed: (Pecherski, translated by Creer (1970); McElhinny and Burek (1971); Johnson, Nairn, and Petersen (1972); Pecherski and Khramov (1973); and Helsley (1973)). As Helsley (1973) stated, inter-regional correlation did not exist and much study must be done before Mesozoic magnetic chronology correlation becomes a reality.

As previously mentioned, red bed sequences are still somewhat of a puzzle to sedimentary petrologists and stratigraphers. There have been many excellent studies of red bed sequences done worldwide. The studies include: Van Houten (1961, 1964, 1968, 1972, and 1973); Walker and Ribbe (1961); Walker and Honea (1969); and Walker (1967a, 1967b, and 1974).

Since this study deals with the remanent magnetization of red beds, it was necessary to evaluate the origin of red beds. This involved all variables of red bed origin: depositional mechanism, source area, paleoclimate, mineralogy (especially magnetic minerals), post-depositional history, and finally, diagenesis and lithification, along with possible post-lithification history.

The major questions that remain unanswered about the origin of red bed sequences are how and when did they acquire their abundant hematite, some of which is responsible for the red coloration? Of course, these questions are closely related to their acquisition of remanence. Essentially, the magnetic remanence is carried by this hematite, some of which may be specularite. Is the hematite of detrital origin or a secondary, authigenic growth formed at the expense of a host mineral (hornblende or some other iron silicate)? Has the hematite formed as a cement that precipitated from fluids moving through the rocks? Perhaps it was a recrystallization resulting from pressure solution. Of course, any combination of these processes is possible.

It can be said that all red beds do not have the same origin. Several workers specifically examined the red bed origin problem in conjunction with paleomagnetism. These workers include Van Houten (1973) and Larson and Walker (1975).

There had been many studies noting the magnetic behavior of not only red bed sequences, but sedimentary rocks in general. These studies have helped to evolve the presently accepted treatment of sedimentary rocks in paleomagnetic study and technique.

Graham (1949) was one of the very first to examine remanence of sedimentary units. Creer (1959) and Chamalaun and Creer (1964) were pioneers in the use of thermal demagnetization for sedimentary rocks, and particularly, red beds. As mentioned previously, Picard, Helsley, Baag, Steiner, and Strangway have studied extensively the magnetic behavior of red bed sequences found in southwestern U.S.

One of the purposes of this study was to compare two different demagnetization techniques to gain an insight into the magnetization history of the Newark Group. The two treatments included stepwise thermal demagnetization and chemical leaching of iron oxides.

For determining the best temperatures for thermal treatment to be utilized for this study, much previous work was examined closely. These included: McMahon and Strangway (1968); Reeve and Helsley (1972); Baag and Helsley (1974a and b); and Helsley and Steiner (1974). All of this work was done in the southwestern U.S. In the eastern Newark-Gettysburg basin, previous thermal work examined included that done by McIntosh (1976).

For the chemical leaching procedures, nearly all experimental techniques were obtained from Park (1970) and Roy and Park (1972) who gave extensive details and experimental results on the best shape specimen to be leached, kind and strength of acid, and the ideal time needed to complete leaching procedures. Collinson (1967) also referred to chemical demagnetization in his studies. Reeve (1975) recently stated that chemical leaching procedures should be altered to include a thorough washing of acid from the specimens before measurement.

Summarizing the previous work done and of interest to this study, there exists an inexhaustible amount of literature available. There are quite a few classical papers that should not be overlooked. However, it is generally felt that early undemagnetized results should be viewed cautiously.

More study needs to be done to answer the origin of red bed dilemma. Finally, if a Mesozoic polarity chronology is to be developed and inter-regional correlations are to become a reality, more work needs to be done. Perhaps other red bed questions will be answered in doing so. It is hoped that this study of red beds in the Newark-Gettysburg basin will contribute to an enlightenment of the origin of red bed remanence.

GEOLOGIC SETTING

Structure

The Newark-Gettysburg basin is the largest of the late Triassic-early Jurassic basins found in eastern North America extending almost 200 km from New York to Maryland (Figure 1). The basins lie to the east of the Appalachians and generally parallel the Appalachian trend. The basins contain non-marine sediments which, for the most part, are red beds. Igneous intrusives and extrusives of late Triassic (Jurassic) age form sills, dikes, and flows within the sediments.

Metamorphic rocks of Precambrian age bound the northern and northwestern margins of the Newark-Gettysburg basin in New Jersey, New York, and eastern-most Pennsylvania. Lower Paleozoic sedimentary rocks and Precambrian metavolcanic rocks bound the western margins of the basin in Virginia, Maryland, and east-central Pennsylvania.

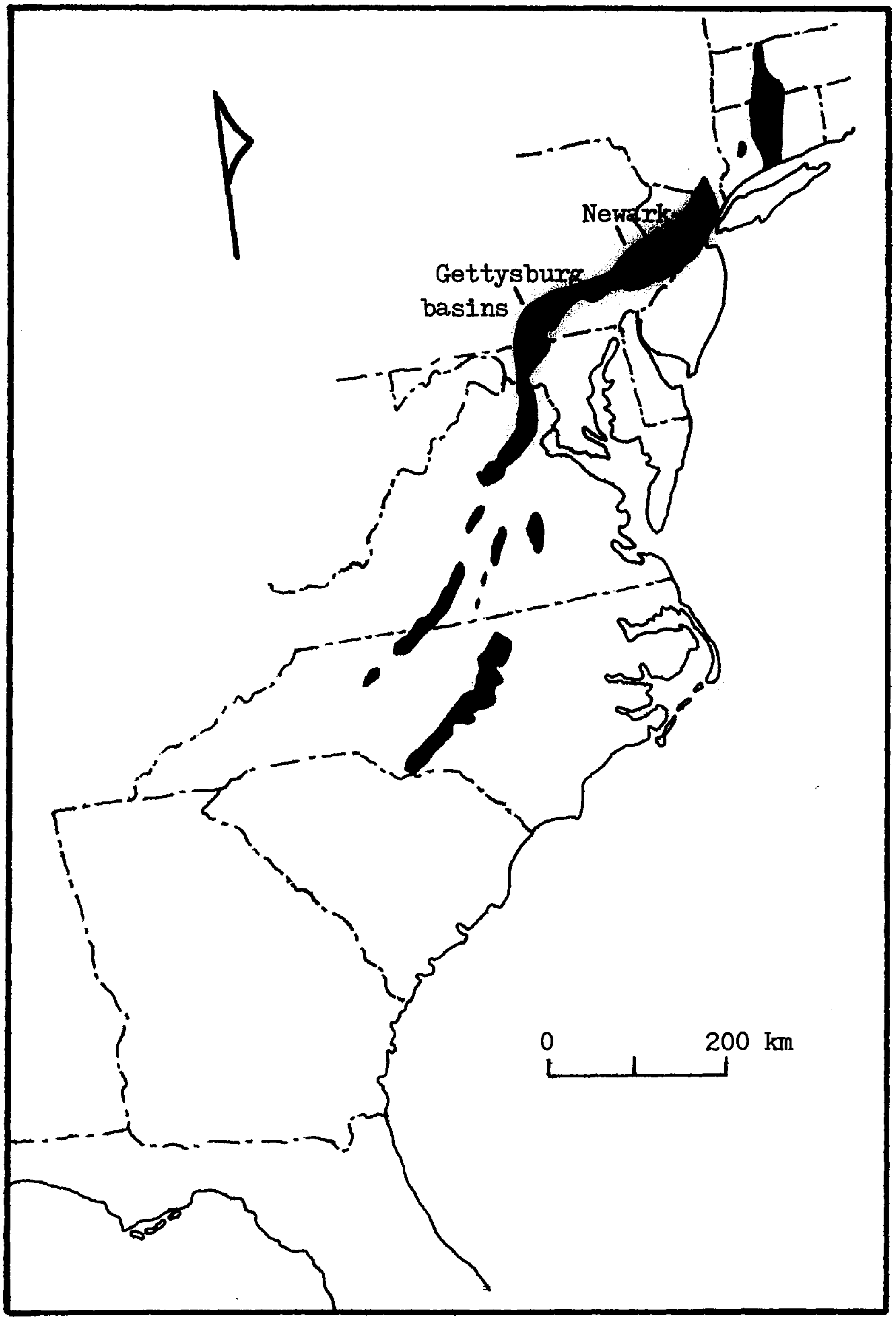


Figure 1. Triassic basins of the eastern United States.

Along the south and southeast margin of the basin, the Triassic sediments unconformably overlie Lower Paleozoic metasediments and, locally, Precambrian granitic and metamorphic rocks. Cretaceous and younger sediments of the coastal plain cover the Triassic along portions of eastern and southeastern basin margin.

The primary question that exists about the structure of the Newark-Gettysburg basin is whether the basin is a graben, half-graben, or simply a downwarping of the crust formed from tensional forces and crustal thinning. Coincident with this question is whether the faulting observed within the basin and along the margins is syndepositional or post-depositional and the exact nature of this faulting.

Early thoughts on the origin of the basin include Roger (1858) who believed the dip of the beds within the basin was due to sediments flowing from a delta in the southeastern portion of the basin. Davis (1886, 1898) suggested a two phase origin of the basin in which initial downwarping created the basin. After the basin was filled with sediments, subsequent faulting and tilting occurred. Barrel (1915) believed that deposition and faulting were contemporaneous.

Several workers (Russel, 1892; Barrel, 1915; and Sanders, 1963) believed the eastern Triassic basins were originally one large fault graben or at least the Newark-Gettysburg basin and Connecticut Valley basin were one in Triassic times. Evidence for this was claimed by the fact that the North Carolina and Newark-Gettysburg basins each have three distinctive formations. In addition, three lava flows are found in both the Connecticut Valley and Newark basins. Later paleomagnetic work (de Boer, 1968) showed that each of the three lava flows in the Connecticut Valley basin had different TRM inclinations and therefore were not contemporaneous, whereas the Watchung flows were essentially from the same magmatic event.

Other workers do not believe in the single, once connected eastern Triassic graben, but believe the basins were a series of single depositional basins as we see today (Johnson and McLaughlin, 1957; Klein, 1962; and Faill, 1973).

The Newark-Gettysburg basin has generally been interpreted as a half-graben structure resulting from normal faulting during the Palisades disturbance (Glaeser, 1966). This movement post-dated the main tectonic mountain building event associated with the Appalachian orogeny. According to the half-graben hypothesis, the basin is bounded on the north and northwest margins by normal faults. This faulting is not always obvious. The other borders of the basin lie unconformably upon Lower Paleozoic rocks.

Faill (1973) interpreted the basin as a simple downwarping of the crust which was filled with sediments from all sides. He proposed a two stage tectonic origin of the basin. Phase one consisted of the creation of the sedimentary basin. At this time, faulting was absent and the basin was formed by simple downwarping of the crust as a consequence of crustal extension and thinning. This was probably related to the initial opening of the Atlantic. Toward the end of basin filling, crustal thinning progressed so that tholeiitic magma rose from the upper mantle and intruded the sediments. Phase two of the basin included a deformational stage when the basin was rotated and tilted to the North and Northwest.

Recently, Sumner (pers. comm.) from gravity work throughout the basin and along the border margins, concluded that the southeastern border of the Newark basin was a normal fault and not an overlap. The Newark basin could then be interpreted as a true graben structure bounded by large normal faults on both margins.

Regardless of how and when the basin faulting occurred, faulting in these eastern U.S. Triassic basins were tensional events related to the opening of the Atlantic in late Triassic-early Jurassic times. The basins may even represent failed arms of the mid-Atlantic rift system. The change in stress field orientation marked the end of collision of the North American and African plates. The basins to the east of the Appalachians were filled with continental sediments obtained from the adjacent highlands. These sediments preserved the earth's magnetic field direction during their post-deposition and lithification stages in Triassic and Jurassic times.

Stratigraphy

Glaeser (1966) carried out an extensive study of provenance, dispersal, and depositional environments of the sediments found in the Newark-Gettysburg basin. Glaeser (1966) from Kummel (1897) considered all the stratigraphic units within the basin the Newark Group and summarized the units in the following manner (Table 1).

East of the Schuylkill River, the Stockton Formation, a

TABLE 1. STRATIGRAPHIC SUMMARY OF THE NEWARK GROUP IN THE NEWARK-GETTYSBURG BASIN (after GLAESER, 1966).

PA-MD. BORDER AREA (SW OF SUSQUEHANNA RIVER)	NARROW NECK OF TRIASSIC OUTCROP BELT (GENERALLY BETWEEN SCHUYLKILL & SUSQUEHANNA RIVERS IN PA)	EASTERN PA AND WESTERN N.J.
GETTYSBURG FORMATION[1] 15,500 ft thick (4.7 km) Red medium-to-fine-grained sandstones and shales, with conglomerates in upper part. Heidlersberg (middle) Member is red, green, and gray shale and argillite with minor gray to white sandstone.	GETTYSBURG FORMATION (in western part)[2] 10,200 ft thick (3.1 km)	BRUNSWICK FORMATION 7,000 ft plus thick (2.1 km) Red shales, siltstones, and sandstones. Conglomerates and coarse sandstones in upper part. Some gray shale and argillite near base,
Conewago (lower) Member, a conglomerate.	BRUNSWICK FORMATION (in eastern part)[2] 19,000 ft thick (6.1 km) Conglomerates, coarse sandstones[3], and minor shales. Robeson and Furnace Ridge Members are quartz-pebble conglomerates.	LOCKATONG FORMATION[4] 3,800 ft plus thick (1.2 km) Upper part-alternating red and gray argillite and shale. Lower part-dark-gray shale and argillite with siltstone and sandstone near base.
NEW OXFORD FORMATION[1] 6,900 feet thick (2.1 km) Arkose, conglomerate, and red sandstone, siltstone, and shale. Unconformable upon Lower Paleozoic and Precambrian rocks.	NEW OXFORD FORMATION (in western part)	STOCKTON FORMATION 5,000 ft thick (1.5 km) Arkose, conglomerate, and red sandstone, siltstone, and shale. Unconformable upon Lower Paleozoic and Precambrian rocks. Top gradational with overlying Lockatong Fm.
	STOCKTON FORMATION (in eastern part)	

[1]Note: marked lithologic similarities between Gettysburg Fm and Brunswick Fm, and between New Oxford Fm, and Stockton Fm.

[2]Demarcation between Gettysburg is the second major, irregularly trending diabase body west of Schuylkill River.

[3]McLaughlin (1939) noted that these coarse clastics are lateral facies equivalents of fine red sandstone, siltstones, and shales of Brunswick and Gettysburg Fms.

[4]Note: eastern extensions buried beneath Coastal Plain sediment: western limit lenses out west of Schuylkill River in PA.

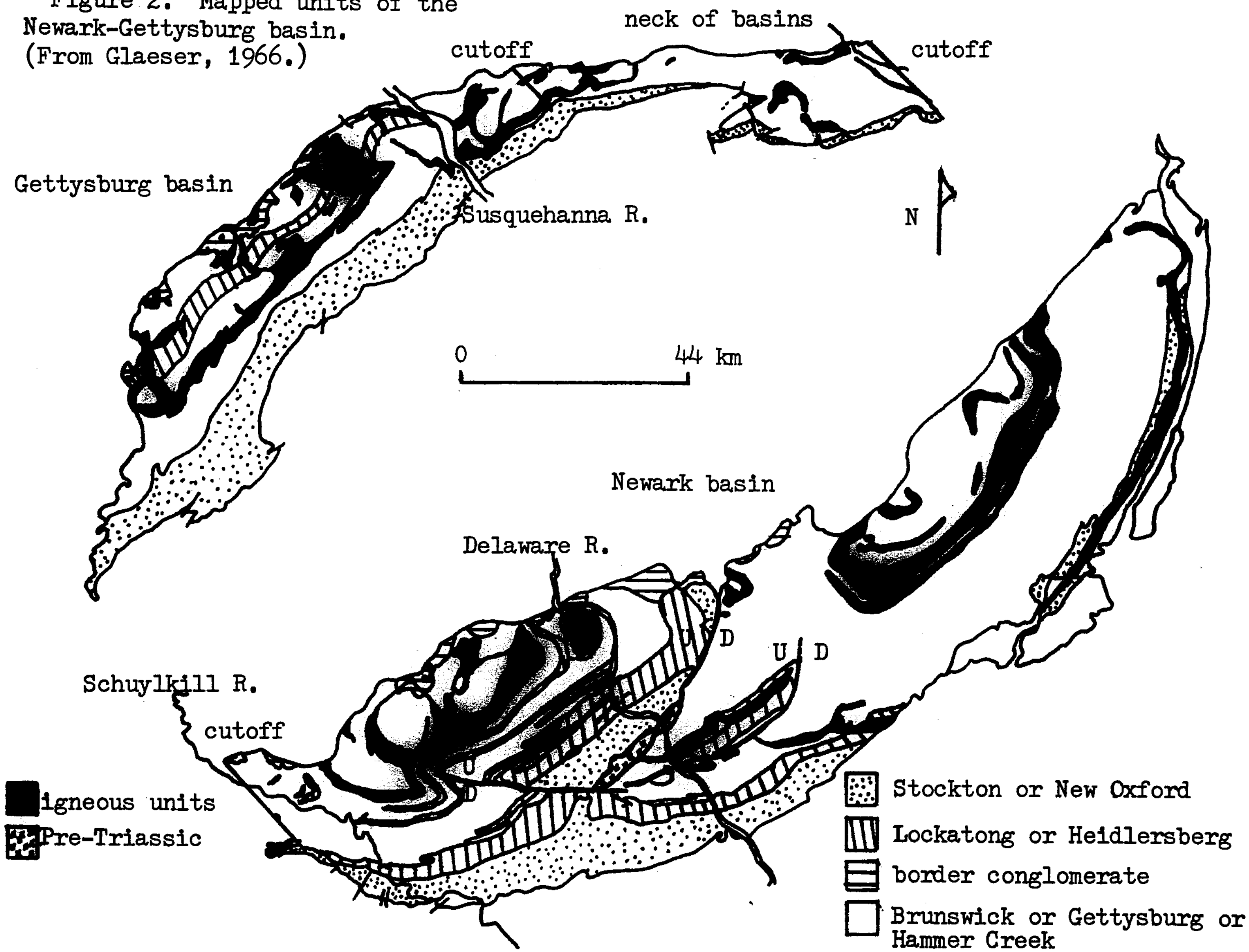
feldspathic sandstone and conglomerate unit occurs. This is overlain by black to blue-gray argillite and shale of the Lockatong Formation. Interfingering laterally and vertically with the Lockatong are the red argillites, shales, siltstones, mudstones, and the fine-grained sandstones of the Brunswick Formation.

To the west of the Susquehanna River a similar stratigraphic section occurs. The lateral equivalent of the Stockton Formation is the New Oxford Formation. It is succeeded by the red, fine-grained sandstones, siltstones, and shales of the Gettysburg Formation. The Heidlersberg Member of the Gettysburg Formation is a black to blue-gray argillite, similar in appearance to the Lockatong Formation. In the narrow belt between the Susquehanna and Schuylkill Rivers, the equivalent Stockton and New Oxford Formations are overlain by a coarse sandstone and conglomerate. This rock unit, the Hammer Creek Formation, is the lateral facies equivalent of the Gettysburg and Brunswick Formations. Figure 2 shows all primary mapped units of the Newark-Gettysburg basin.

Because the Lockatong and Brunswick Formations are interfingering to a great extent, Glaeser (1966) chose to call each a lithosome instead of a formation. This terminology will not be used in this study, and the conventional formation terminology will be maintained.

In addition to these sedimentary lithologies, quartz-normative tholeiitic magma of upper mantle origin has intruded these sediments as extensive thick saucer-shaped sheets (Faill, 1973). The

Figure 2. Mapped units of the Newark-Gettysburg basin. (From Glaeser, 1966.)



magmatic activity associated with these intrusive bodies occurred late in the basin filling.

Because of the nature of this study, it is of interest to consider the origin and depositional environment of these non-marine sediments contained within the Newark-Gettysburg basin. The source of hematite in these rocks is a critical question, for this mineral is the primary carrier of stable remanence in these red beds.

Sedimentary petrology

In his study of sedimentary petrology of the basin sediments, Glaeser (1966) noted that the Stockton and New Oxford sediments were clastics with an absence of hematite at sharp grain-boundary contacts. Also, the lack of hematite disseminated in the silica cement suggested that the silica was deposited first and then the hematite precipitated following partial lithification and compaction. Both cementing agents precipitated at an early stage of burial.

On the contrary, Glaeser (1966) noted that in the Lockatong, Brunswick, and Gettysburg Formations, as well as the Hammer Creek and Heidlersberg Members, the hematite was present at tight grain-boundary contacts, disseminated in some of the silica cement, and entrapped along silica-quartz boundaries. This evidence seemed to suggest that the hematite was primary, namely inherited from the source.

Summarizing the diagenesis of the formations within the basin, Glaeser (1966) noted that in the Stockton and New Oxford Formations hematite was precipitated, matrix replacement was active, and authigenesis was minor. The diagenetic sequence consisted of compaction, silica precipitation, then hematite precipitation.

For the Brunswick, Lockatong, Gettysburg, Heidlersberg, and Hammer Creek lithologies, Glaeser (1966) found that the hematite was inherited, that there was minor matrix replacement, and that authigenesis was active in all the formations except the Hammer Creek. The diagenetic sequence consisted of detrital hematite, precipitation of clouded carbonate and pyrite, silica precipitation, and finally, precipitation of clear carbonate and dolomite rhombs.

Depositional environment

From the sedimentary petrology study, Glaeser (1966) synthesized the origin of the basin and the sediments contained within. He acknowledged three major events in deposition and noted that each was marked by a change in provenance and/or dispersal (Figure 3).

In the first stage, the sediments that became the Stockton and New Oxford Formations were eroded from high grade metamorphic terrain to the southern part of the basin. The sediments underwent high mechanical activity during this period of deposition and were, for the most part, well-sorted. The clay found in the matrix was a result of the destruction of feldspar. Hematite was precipitated in the finer-grained sediments after deposition.

In the next stage of deposition, there was a shift of sediment influx to the northern sedimentary and/or low grade metamorphic provenance. The zones of influx were limited and material was transported laterally within the basin. In the center of the

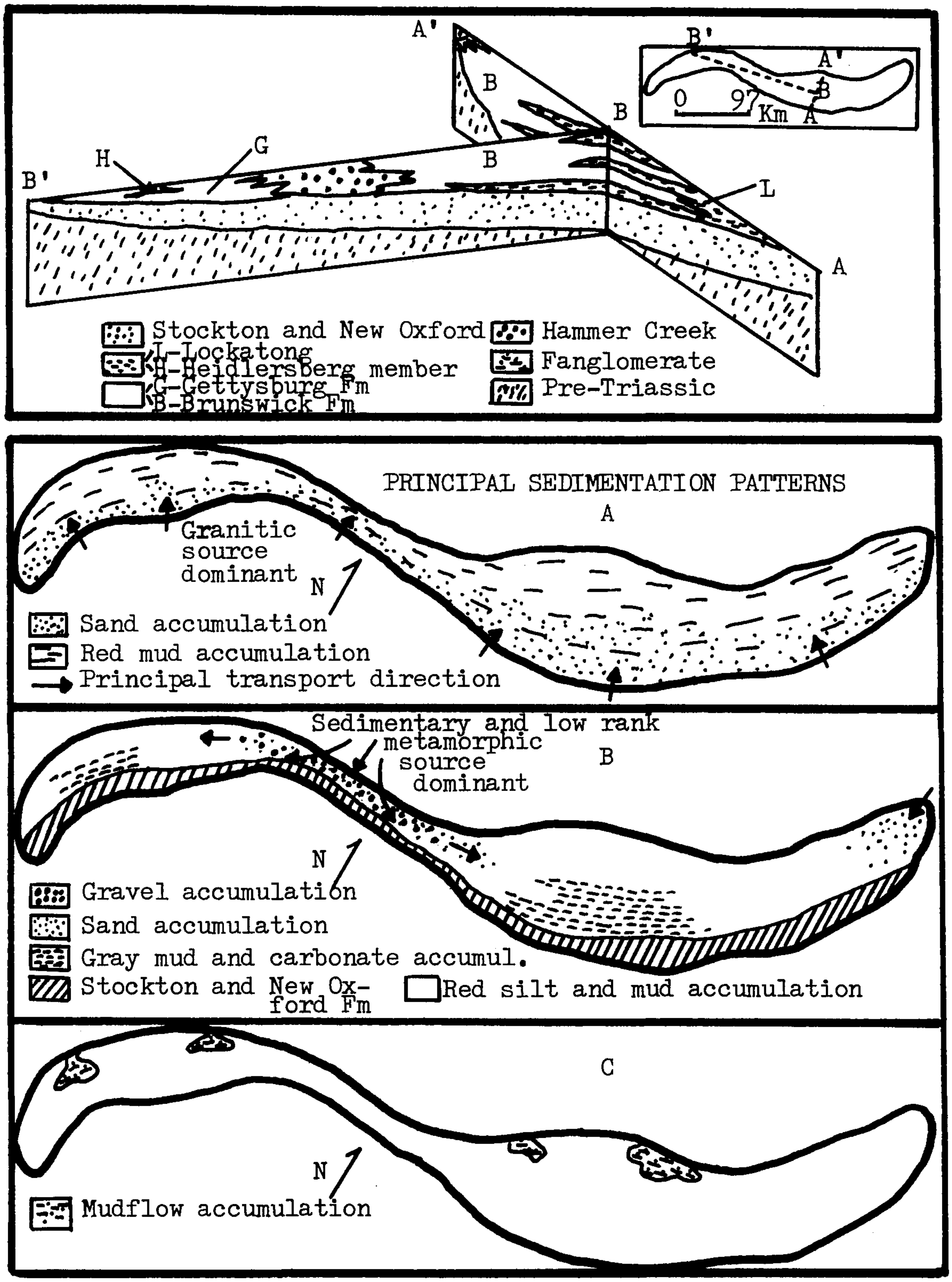


Figure 3. Three depositional events in the Newark-Gettysburg basin (from Glaeser, 1966).

basin, dark gray muds, represented by the Lockatong and Heidlersberg lithologies, accumulated.

The final stage of development of the basin is represented by the conglomerate deposited on top of the Brunswick and Gettysburg Formations along the northern border of the basin. According to Glaeser (1966) the nature of the conglomerates are thought to represent mudflows from streams flowing across fault scarps at the northern margin. Since the conglomerates do not interfinger with the finer-grained Brunswick and Gettysburg Formations, this suggests faulting was active only during final stages of basin deposition. Glaeser (1966) believes that little erosion of the basin sediments occurred since their Triassic deposition, and that nearly a complete record of sedimentation and border margins are found now. On the other hand, Faill (1973) believes a considerable volume of Triassic rocks have been removed by erosion.

PALEOMAGNETIC TECHNIQUE AND EXPERIMENTAL METHODS

The investigation of magnetic remanence of these Triassic red beds proceeded in three parts, each independent of the other. The study involved: (1) comparing thermal demagnetization results with chemical leaching results as both were applied to different red bed lithologies, (2) observing and comparing variations in magnetic direction and intensity for a confined stratigraphic section during the two demagnetization procedures, and (3) sampling several stratigraphic sections for the purpose of locating reversely magnetized intervals to be used as an aid in Mesozoic correlation.

Thermal treatment and chemical leaching applied to different rock lithologies

Oriented samples representing the different rock lithologies were collected from throughout the Newark-Gettysburg basin. The samples came from the entire length of the basin, but sites were limited by the fact exposures were sparse. Figure 4 locates the position of each site in the basin on an index map. One sample was also collected in the Culpeper basin at the southern-most extent of the Newark-Gettysburg basin. The samples collected were not only red siltstones, sandstones, mudstones, and shales, but also included a blue-gray argillite found in the Lockatong Formation and a yellowish-arkosic sandstone sampled in the Stockton Formation. Each location was identified by a number. At each site, each sample collected was given the site number and hand sample number. Table 2 summarizes information for the samples collected from each location by describing their identification code, rock lithology, formation mapped in, bedding attitude, and latitude and longitude of the site.

From each sample listed in Table 2, three cores were drilled along the same bedding plane. It was believed the NRM direction and intensity would be similar since the cores would be from the same time horizon. The cores were sized to proper dimensions and measured as right circular cylinders with diameters and heights of 2.5 cm. The volume of the cylinders measured approximately

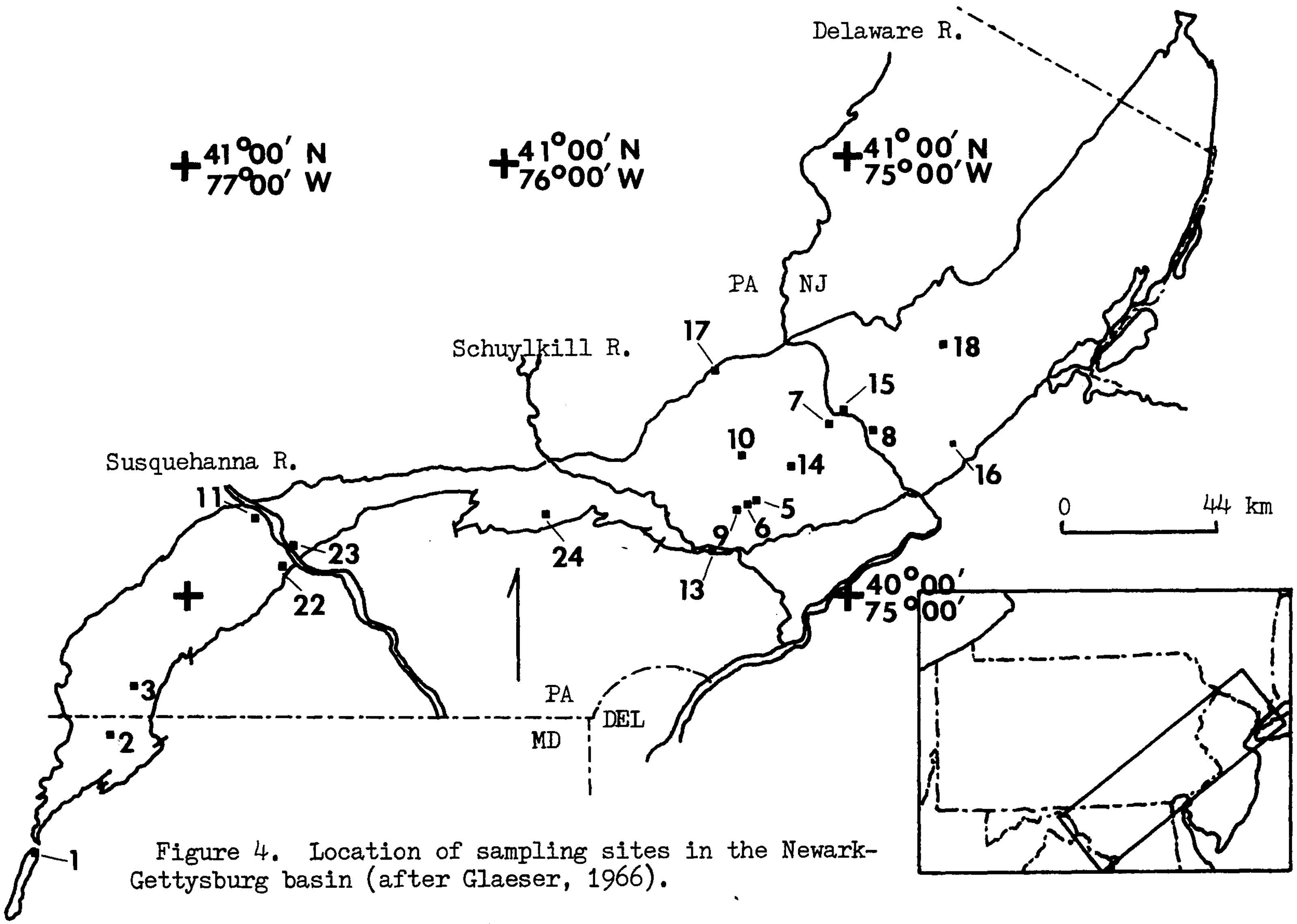


Figure 4. Location of sampling sites in the Newark-Gettysburg basin (after Glaeser, 1966).

TABLE 2. SUMMARY OF SITE AND SAMPLE INFORMATION

SITE-SAMPLE	ROCK LITHOLOGY	FORMATION MAPPED	BEDDING ATTITUDE (DIP AZIMUTH, DIP)	LOCATION-TOPOGRAPHIC MAP[1]
1-3	red mudstone	Culpeper basin	$304^\circ, 11^\circ$	$39^\circ25'05''$N $77^\circ27'28''$W Frederick, Md
2-1 2-2	red shale red siltstone	Gettysburg Fm	$318^\circ, 14^\circ$	$39^\circ40'47''$N $77^\circ14'00''$W Taneytown, Md
3-1	red shale	Gettysburg Fm	$302^\circ, 16^\circ$	$39^\circ47'18''$N $77^\circ08'35''$ Gettysburg
5-6[2]	red shale	Brunswick Fm	$310^\circ, 10^\circ$ $(326^\circ, 10^\circ)$A"-E[2]	$40^\circ12'22''$N $75^\circ16'30''$W Lansdale
6-1[2] 6-2	red shale red shale	Brunswick Fm	$336^\circ, 7^\circ$	$40^\circ11'35''$N $75^\circ17'33''$W Lansdale
7-1	drab, red shale-mudstone	Stockton Fm	$330^\circ, 10^\circ$ $(317.5^\circ, 24.6^\circ)$A,B,C[2]	$40^\circ23'36''$N $75^\circ03'26''$W (B,C)[2] $40^\circ23'48''$N $75^\circ03'24''$W (A)[2] Lumberville, PA-NJ
8-1	yellow, arkosic sandstone	Stockton Fm	$350^\circ, 13^\circ$	$40^\circ25'41''$N $75^\circ01'19''$W Stockton, PA-NJ
9[2]	red shale	Stockton Fm	$322.2^\circ, 8.6^\circ$	$40^\circ10'19''$N $75^\circ18'23''$W Lansdale
10-2	red shale-mudstone	Brunswick Fm	$290^\circ, 9^\circ$	$40^\circ18'06''$N $75^\circ19'08''$W Telford

[1]Maps are Pennsylvania $7\frac{1}{2}'$ quadrangles except where indicated as N.J. or MD.

[2]Sampling for magnetic stratigraphy at this site in addition to hand samples collected.

TABLE 2, cont...

SITE-SAMPLE	ROCK LITHOLOGY	FORMATION MAPPED	BEDDING ATTITUDE (DIP AZIMUTH, DIP)	LOCATION TOPOGRAPHIC MAP[1]
11-1	red, arkosic sandstone	Gettysburg Fm	$290^\circ, 17^\circ$	$40^\circ06'44''$N $76^\circ47'07''$W Dover
13-1	red siltstone	Stockton Fm	$305^\circ, 13^\circ$	$40^\circ04'34''$N $75^\circ24'45''$W Valley Forge
14-4	red shale	Lockatong Fm	$296^\circ, 18^\circ$	$40^\circ16'48''$N $75^\circ09'39''$W Doylestown
15-4 15-5	blue-gray argillite red shale and mudstone	Brunswick Fm	$0^\circ, 15^\circ$	$40^\circ22'50''$N $74^\circ54'56''$W Stockton, PA-NJ
16-2	drab, red mudstone	Brunswick Fm	$300^\circ, 12^\circ$	$40^\circ21'35''$N $74^\circ41'00''$W Princeton, NJ
17-1	drab, red conglomerate	conglomerate facies of Brunswick Fm	$325^\circ, 5^\circ$	$40^\circ30'09''$N $75^\circ23'31''$W Allentown East
18-1	red shale	Brunswick Fm	$294^\circ, 7^\circ$	$40^\circ33'20''$N $74^\circ42'30''$W Raritan, NJ
22-4	red siltstone	New Oxford Fm	$332^\circ, 9^\circ$	$40^\circ04'48''$N $76^\circ41'59''$W York Haven
23-3	reddish-yellow arkosic sandstone	New Oxford Fm	$0^\circ, 27^\circ$	$40^\circ06'54''$N $76^\circ41'17''$W York Haven
24-2[2]	red conglomeratic sandstone	Hammer Creek Fm	$45^\circ, 20^\circ$	$40^\circ10'39''$N $75^\circ55'36''$W Reading

[1] Maps are Pennsylvania $7\frac{1}{2}'$ quadrangles except where indicated as N.J. or MD.

[2] Sampling for magnetic stratigraphy at this site in addition to hand samples collected.

10^3. The cores were later used for either the chemical leaching or thermal demagnetization procedures.

All laboratory measurements were done at Princeton's Rock Magnetism Laboratory. The NRM of each core was measured on a PAR spinner magnetometer. If the cores from the same sample had different NRM directions, they were disqualified from the following demagnetization procedures.

Chemical leaching of the hematite

Nearly all the methods followed for the chemical leaching treatment were based on experimental results of Park (1970) and Roy and Park (1972). The specimens chosen for leaching were cored through the center, leaving an axial hole with a diameter of 1 cm. This was done to increase the surface area of the specimen, therefore decreasing the leaching time required. Of the original 10 cm^3 volume, approximately 2 cm^3 were removed in this procedure.

Park's results (1970) from Mississippian and Pennsylvanian sandstones of Nova Scotia showed that for a standard size core with an axial hole of 1 cm diameter, a stable endpoint in the leaching was reached in less than 10 days. This endpoint was recognized when the decrease in intensity ceased and a plateau was reached. Most of Park's samples had 3-5 % of the original intensity remaining at this time. Since many of the specimens used in this study were fine-grained, less permeable shales and mudstone than the sandstones used by Park, it was expected that the leaching period would extend longer.

After drilling the axial hole of 1 cm diameter, the NRM of the samples were again measured. These measurements were labeled NRMh. Chemical leaching of the iron oxides began within 24 hours of the NRMh measurements. 6 N HCl acid was used for the first 5 days of leaching. For the remaining time, 8 N strength was used. Each specimen was placed in a 50 ml glass beaker and covered completely with the acid. After two or three days, the samples and beakers were rinsed, and fresh acid was placed in the beakers. The samples were placed on the axis of the cylinder and not on the top or bottom surface area of the cylinder. This was done so there would be no preferred direction as the specimens leached.

At least 24 hours prior to measuring the magnetization of the samples, they were washed thoroughly and allowed to soak in fresh water. The water was changed every few hours. With the exception of one specimen, the samples were measured at the following time intervals: NRM, NRMh, 5 days, 10 days, 20 days, 30 days, and 40 days. In addition to the leaching, at the end of 40 days, the specimens were thermally demagnetized at 265° C and 388° C $\pm$ 10° C. The magnetic field in which the samples were heated and cooled was sustained at less than 10 γ (see section on Thermal treatment). From these measurements, the direction and intensity of remanent magnetization was calculated. Well after the specimen had been measured and had time to dry, the mass was measured on a Mettler balance and recorded to the nearest $\pm$ 0.001 gr. Intensity of magnetization was then reported in emu/gr in addition to relative intensity, comparing the specimen at each time interval to the original NRMh obtained prior to leaching. The information for all cores is summarized in Appendix 1, including: demagnetization level; interpreted polarity (N, R, or M); magnetic declination and inclination, both uncorrected and corrected for bedding attitudes; relative intensity (NA indicates not applicable); and finally, J (10^{-6} emu/gr).

Thermal treatment

Standard stepwise thermal treatment was carried out on one of the three specimens cored from each sample. NRM was measured twice for these samples as a test for stability of remanence. The interval of time between measurements was about three months and samples were stored in μ-metal protection between measurements. The stepwise temperatures of thermal demagnetization included the following, $\pm$ 10° C: 265° C, 400° C, 530° C, and 600° C.

Thermal demagnetization apparatus included a standard Helmholtz coil system with a manually operated power supply. The earth's field (x, y, and z components) was nulled. After all three components of the field were nulled, the specimens to be heated were placed on a copper platform in the center of the Helmholtz coils. The platform held a maximum of 28 specimens, but usually only 20 specimens were treated at a time to prevent a possible field induced by the specimens themselves.

The oven was them lowered over the specimens and heating proceeded. Monitoring of the temperature was done with a thermocouple placed within the furnace. The temperature desired was attained and held for 20 minutes. At the termination of this period, the furnace was removed and the samples were allowed to cool in the open air. Cooling proceeded rapidly and usually took about 20 minutes. During the heating and cooling process, the earth's magnetic field was monitored and sustained at less than 10 γ.

When the specimens were cool enough to handle, their magnetic remanences were measured immediately. The results from these measurements are included in Appendix 1 along with the chemical leaching data for comparison. Appendix 1 was prepared as a quick comparative table of results from chemical leaching versus thermal treatment (especially polarity and intensity). In addition, the table contains the following information for thermally demagnetized samples: demagnetization level; polarity (N, R, or M); magnetic declination and inclination, uncorrected and corrected for bedding attitudes; relative intensity-comparing thermal demagnetization temperatures to the second measured NRM (NA indicates not applicable); and J (10^{-6} emu/gr).

Stratigraphic control on demagnetization procedures

In addition to a blue-gray argillite (15-4) collected from site 15, a large sample (15-5) was also selected for stratigraphic control on demagnetization procedures. The sample measured approximately 33 cm by 33 cm and consisted of red mudstones and shales in a recognizable bedded sequence. Because of the small dimensions of the sample, the visual bedding was assumed to represent distinct time horizons. From each of four different time horizons (bedding planes) of the sample, four cores were obtained. These sixteen cores were divided into two specimens each with the exception of one which was not large enough. Thus, a total of thirty-one specimens from sample 15-5 were collected.

The specimens were identified by a code further described in Appendix 2. Bedding horizons 4 and 3 appeared relatively uniform. However, 2 and 1 showed possible signs of disturbance and/or turbulent flow such as sedimentary structures including ripple marks and possible slumping.

From each of the sixteen drilled cores, one of the two specimens from a core was chosen for thermal demagnetization and the other for chemical leaching treatment. Again, for the specimens to qualify they were required to have similar NRM directions. The demagnetization procedures remained the same as for sites 1-24 (see Thermal treatment and chemical leaching applied to different rock lithologies). The information from each specimen through the chemical leaching or thermal demagnetization procedure is summarized in Appendix 3 that compares the two demagnetization histories.

For the leaching history each time interval is compared with the initial NRMh direction and intensity. For the thermal treatment, NRM was measured twice. The second NRM is used for the comparative relative J through demagnetization. This appendix was meant to be a quick comparative reference for both demagnetization procedures and includes: demagnetization level; interpreted polarity (N, R, and M); magnetic declination and inclination, both uncorrected and corrected for bedding attitude; relative intensity; and J (10^{-6} emu/gr).

Magnetostratigraphy

Development of several magnetostratigraphic columns was initiated in this study of the Newark-Gettysburg basin. During widespread sampling throughout the earlier stages of this study, it was realized that this sampling could also be utilized as a reconnaissance for reversely magnetized intervals of the Newark Group. After initial NRM and subsequent thermally demagnetized measurements of magnetic direction, it was well-established that several sizable outcrops had been found to have reversely magnetized samples. It would be profitable to sample magnetostratigraphically at these sites at closely-spaced intervals to determine the size of the reversely magnetized sections. These could aid in development of Mesozoic magnetic chronology.

Sites 5, 6, and 9

Field sampling

Site 5

Site 5, located within the Lansdale $7\frac{1}{2}$' quadrangle of Pennsylvania at 40°12'22" N, 75°16'30" W, was sampled initially. Sampling was done with a portable gasoline-powered rock drill. The exposure trended, from older to younger units, SE - NW. The total horizontal distance of the outcrop sampled was about 435.5 m. At the SE extent of the outcrop, the units were of the Brunswick Formation and consisted of red fine-grained shales and mudstones to medium-grained, poorly sorted siltstones. These units graded into a blue-gray argillite, then a buff-colored, fine-grained sandstone of the Lockatong Formation. Stratigraphic sampling over the entire outcrop proceeded on the average of every 1.2 m intervals. Totally, a stratigraphic section of 75.6 m was sampled with the collection of 61 cores.

Sampling proceeded in several stages. The outcrop was divided into several sections, oldest to youngest: A", A', A, B, C, D, and E. Each section consisted of approximately ten samples with the exception of A". On the average, 30 cores were drilled and oriented in a day. Cores were oriented using a Brunton compass and core orienter designed for this purpose. Each core was given a code consisting of the site number, section letter, and core number. On occasion, a core was divided into two specimens. A specimen number was also recorded as 1, the deepest cored specimen, or, 2, the nearest to the surface. For example:

5 - B - 4 - 1,

would represent site 5, section B, core 4, specimen 1. The specimens were later sized into right circular cylinders of heights and diameters of 2.5 cm each. The stratigraphic and structural features of the outcrop were also mapped during sampling. The average attitude of the beds was N 56° E 10° NW. The entire sampling and mapping of site 5 was done in October and November of 1976.

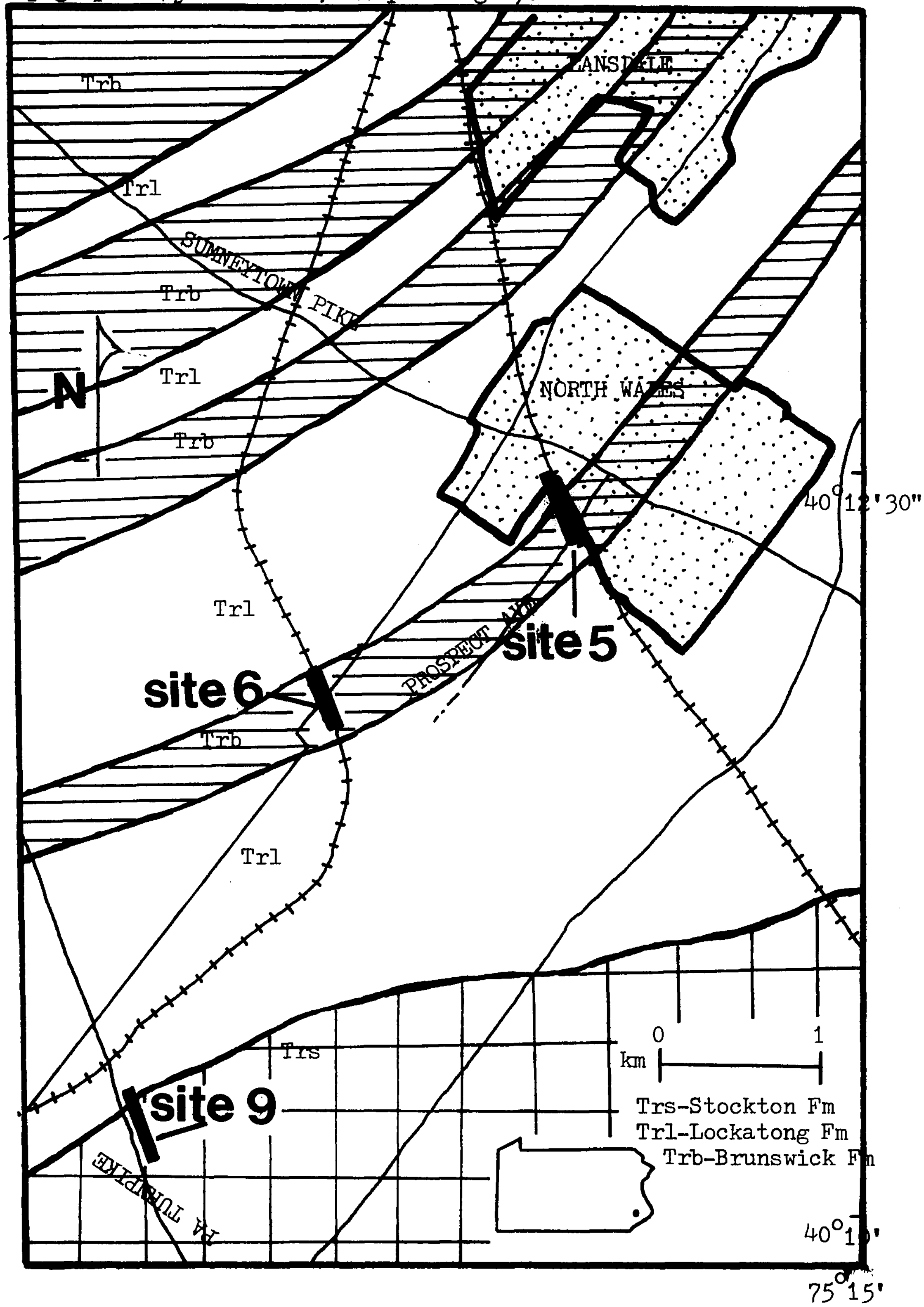
Sites 6 and 9

As an attempt to stratigraphically extend the reversely magnetized interval found at site 5, two nearby outcrops were also sampled. The two sites included site 6, located 1.8 km SW of site 5 at 40°11'35" N, 75°17'33" W, and site 9, located 4.72 km SW of site 5 at 40°10'19" N, 75°18'23" W. Sites 5, 6, and 9 are located on Figure 5, an enlarged map of the 7½' Lansdale, PA quadrangle.

Sampling at site 6 was done in December, 1976, and covered an exposure of 142.3 m of horizontal distance that trended SE-NW, oldest to youngest beds. Four samples were collected at intervals averaging 8.1 m of stratigraphic section, using a portable gasoline-powered rock drill. The total stratigraphic section sampled was 24.5 m. The exposure consisted of red shales and mudstones, again, of the Brunswick Formation, and the average strike and dip of the beds was N 60° E 10.75° NW.

Site 9 at 40°10'19" N, 75°18'23" W was sampled during February, 1977, and was an exposure located along the NE extension of the Pennsylvania turnpike. The total horizontal distance of the exposure sampled was 153 m. Fourteen samples were collected using a portable gasoline-powered rock drill at non-uniform intervals ranging from 1.8-7.7 m. The entire stratigraphic section represented was 26.6 m. The exposure was mapped as the Stock-

Figure 5. Enlarged location map of sites 5, 6, and 9 (taken from U.S. topographic 7½' Lansdale, PA quadrangle).



ton Formation and included red shales and mudstones dipping at an average of 10° NW and striking N 52.2° E.

Demagnetization treatment

All samples from sites 5, 6, and 9 were demagnetized using standard stepwise thermal treatment (see Thermal treatment). Of the 63 cores collected from site 5, several of the cores were long enough to divide into two specimens. When this was possible, the second specimen was measured at NRM and saved for future leaching experiments. From all of the 63 cores collected at site 5, al least one specimen was recovered for thermal demagnetization procedures.

For these 63 specimens from site 5, initial NRM measurements were made. Subsequent thermal demagnetization was carried out at $\pm$ 10° C, 400° C and 550° C. Most of the red bed samples appeared well-behaved and moved progressively nearer to a reversed Triassic field direction. Many of the previously described blue-gray argillites and buff-colored, fine-grained sandstones (sampled in section E at the site) appeared to have a very stable present-day component of the earth's field. This was evident, for their directions at 550° C still appeared mixed. For this reason, these samples and several other red bed samples that might improve with higher temperatures, were additionally demagnetized at 600° C.

From site 6, four samples were collected and thermally demagnetized at 423° C and 550° C, $\pm$ 10° C. Fourteen samples were collected from site 9. All were demagnetized at 400° C and 560° C, $\pm$ 10° C.

The data collected for sites 5, 6, and 9, including NRM and subsequent demagnetization temperatures are listed in Appendix 4. Included are the following: demagnetization level; magnetic declination and inclination, both uncorrected and corrected for bedding attitude; J (10^{-6} emu) and J (10^{-6} emu/gr). In addition, Appendix 5 was prepared as a quick comparative reference for each specimen's relative intensity and magnetic direction through demagnetization. It includes demagnetization level; interpreted polarity (N, R, or M); magnetic declination and inclination, both uncorrected and corrected for bedding attitude; relative intensity compared to NRM; and J (10^{-6} emu/gr). All the samples collected stratigraphically are listed in the Appendices, youngest to oldest, or descending in the time column.

Sites 7 and 24

Field sampling

In addition to sites 5, 6, and 9 located near Lansdale, PA, two other sites were sampled stratigraphically. These included sites 7 and 24. Site 7, located at $40^{\circ}23'36''$ N, $75^{\circ}03'26''$ W was found within the $7\frac{1}{2}'$ Lumberville, PA quadrangle and approximately 2 km W of the Delaware River. The outcrop was not a continuously exposed sequence, but consisted of two exposures separated by a horizontal distance of 0.32 km.

The two exposures of site 7 consisted of a very drab, red shale, mudstone or poorly sorted siltstone of the Stockton Formation. The two outcrops were divided into A, stratigraphically the youngest exposure, and B and C, the oldest exposure. Nine cores were collected from A using a portable gasoline-powered rock drill. The average stratigraphic sampling interval was 8.1 m. A total of 48.6 m of stratigraphic section was sampled from A which had a horizontal extent of 120 m.

Ten cores were recovered from section B and C at approximate stratigraphic sampling intervals of 2 m. The horizontal extent of the outcrop containing B and C was 108 m. With the ten cores collected, a total of 19 m of stratigraphic section was sampled. The average attitude of the beds was N 43.5° E 16.5° NW.

Site 24, located at $40^{\circ}10'39''$ N, $75^{\circ}55'36''$ W within the $7\frac{1}{2}'$ Reading, PA quadrangle was approximately 33 km W of the Schuylkill River and 21 km S of Reading, PA. A total of ten samples were collected. Stratigraphic sampling intervals were non-uniform, ranging from 2.4 - 8.2 m. A total stratigraphic section of 36 m was sampled. The section included red, coarse-grained arkosic sandstone or conglomerate of the Hammer Creek Formation (quartz conglomerate facies of the Brunswick and Gettysburg Formations). The attitude of the beds was measured as N 45° W 20° NE.

Demagnetization treatment

Samples from both sites 7 and 24 were treated by stepwise thermal demagnetization. NRM was initially measured. The samples from site 7 were cleaned at 400° C $\pm$ 10° C. They seemed to have an extremely hard present-day overprint so further thermal demagnetization of all samples from site 7 included 550° C and 625° C, $\pm$ 10° C. Samples from site 24 were cleaned at 400° C and 550° C, $\pm$ 10° C. The results from the measurements of site 7 and 24 specimens were presented in Appendices 6, 7, 8, and 9. Appendices 6 and 8 include magnetic declination and inclination, both uncorrected and corrected for bedding attitudes; J (10^{-6} emu); and J (10^{-6} emu/gr) for each heating treatment. Also provided were Appendices 7 and 9, comparatable tables of intensity and magnetic direction for each specimen itself. They include demagnetization level; interpreted polarity (N, R, or M); magnetic direction, both uncorrected and corrected for bedding attitude; relative intensity; and J (10^{-6} emu/gr).

RESULTS

The results of this study will be presented in three parts. The relationship between each of the three parts will be reserved for the discussion and conclusion sections.

Part I. Chemical leaching compared to thermal demagnetization

Samples collected throughout the Newark-Gettysburg basin represented all sedimentary rock lithologies available. Cores were drilled from the same bedding plane and remanent magnetizations measured. At least two cores were recovered from each sample. One core was used for the thermal demagnetization and the other for the chemical leaching procedure. A comparison of these two treatments resulted in the following observations. (Also see Appendix 1 for a listing of sample demagnetizations). For the reader's reference, Triassic normal, reversed, and present-day directions are shown in Figure 6 (Beck, 1965 found mean Triassic normal direction for Pennsylvania diabase as 359.5°, $+23^\circ$).

Thermally demagnetized specimens were well-behaved. Initial NRM directions were near Triassic normal or reversed direction. As the specimens were stepwise thermally demagnetized at 265° C, 400° C, 530° C, and 600° C, the directions, for the most part, moved progressively toward a better Triassic normal or reversed direction. (Coarse-grained sandstones and conglomerates which had low intensities at NRM tended to show poor or anomalous directions. There were also other anomalous specimens which will be discussed later.)

The results from the chemically leached specimens differed markedly. On the basis of chemical leaching, the majority of the specimens seemed to differentiate three different behaviors and were classified as Group I, II, or III (see Figure 7).

Group I had leached specimens whose NRM directions were near Triassic normal or reversed direction. With increased leaching time, there was little deviation from the initial directions.

Group II has leached specimens whose initial NRM directions were near Triassic normal or reversed, and with increased leaching time, the direction appeared to move nearly antipodal to the ori-

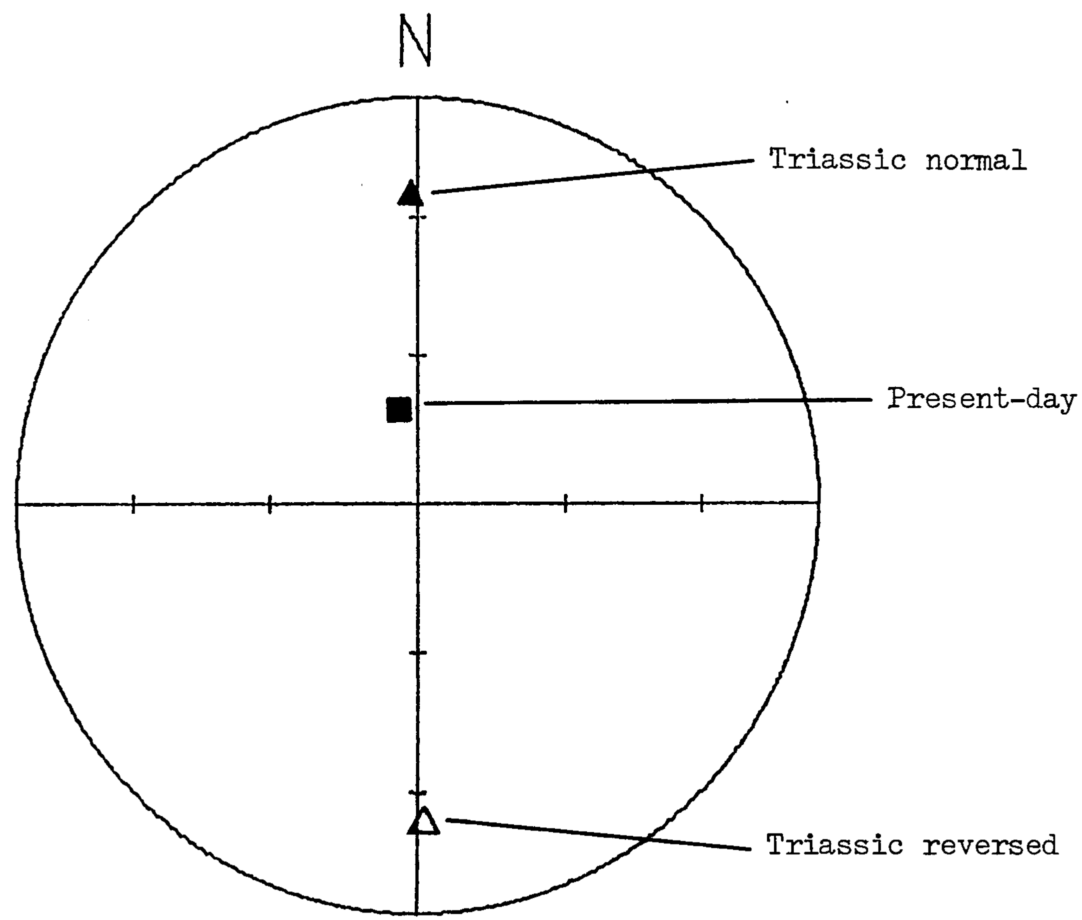


Figure 6. Magnetic directions in the Newark-Gettysburg basin for Triassic and Present-day.

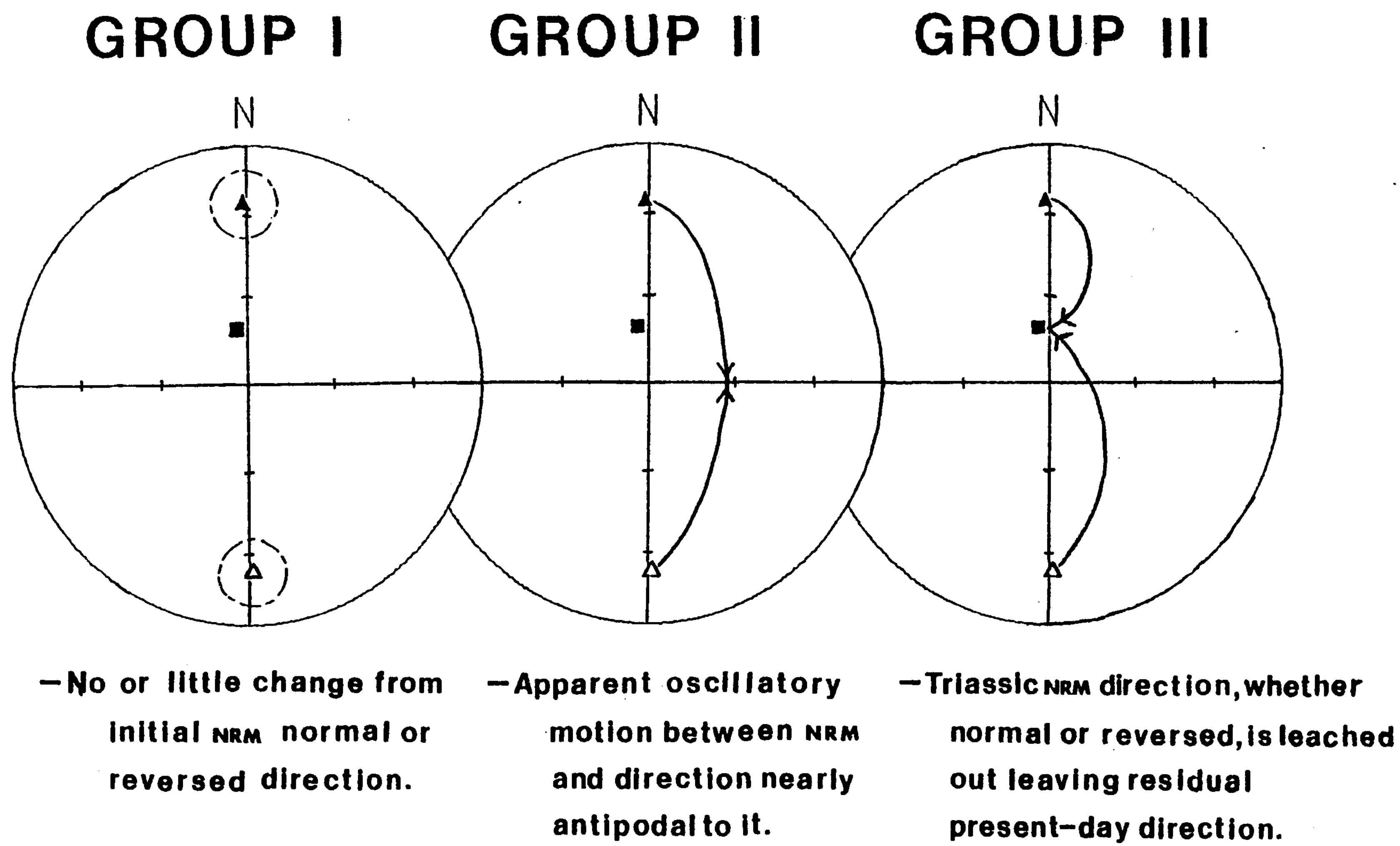


Figure 7. Three groups of red beds observed in the Newark-Gettysburg basin, based on chemical leaching.

ginal direction. For some specimens, the direction appeared to oscillate between the NRM direction and the position nearly antipodal. This movement was slow in some specimens, but in others, the flip took place with no indication that the direction was about to change. The change in direction was often accompanied by a discernible increase in intensity, indicating the probable removal of a component of the original magnetization.

Group III had leached specimens whose initial NRM direction was near Triassic normal or reversed, and with increased leaching time, the Triassic direction appeared to be leached out, leaving a residual direction that was close to the present-day field.

Rather than describe each of these specimens in detail, two samples will be described for each of Groups I, II, and III. The stereonet plots of the remaining specimens that were classified into these groups are available for inspection in Appendices 10, 11, and 12. (Also see Appendix 1 for a listing of each sample through demagnetization.)

The results of both the leaching and thermal demagnetization procedures for all these specimens are shown on equal-area stereonets. (CLH represents chemical leaching history and TDH represents thermal demagnetization history.) On these plots, X = normal inclination (lower hemisphere) and ⭘ = reversed inclination (upper hemisphere). This notation will be used throughout. None of the directions are plotted with bedding corrections made, but the corrected directions are listed in the appendices provided. In addition to the stereonets, the figures contain relative intensity plots at the right. The upper plot is for the leached specimen and the lower plot is for the thermally treated specimen. For the leached specimens, a J_r/J_o was considered 1.0 at the remanence measurement with the axial hole drilled, or NRMh. For the thermally demagnetized specimens, if NRM was measured more than once, J_r/J_o was considered 1.0 for the last NRM measured. All the directions measured are shown on the stereonet, however.

Group I had leached specimens whose magnetization directions changed little through the leaching process. Examples of this group will include samples collected at sites 2 and 18. Figures 8 and 9 show samples 2-1 and 18-1 (specimens 18-1-1, 18-1-2), respectively, through these procedures. Both samples were red beds (see Table 2).

In Figure 8, it can be seen that for the leached specimen at NRM and NRMh (with the axial hole drilled) the directions are near Triassic normal direction. With increased leaching time of 5, 10, 20, 30, and 40 days, the direction deviated little. After being thermally demagnetized at 265° C and 380° C, the direction also changed little. Viewing the accompanying relative intensity plot, a smooth decrease in intensity occurs, and by 40 days, 28 % of the original intensity remains. Little loss occurs after this.

For the thermally demagnetized specimen, NRM-1 and NRM-2, measured at a separation of 3 months, are nearly identical and near

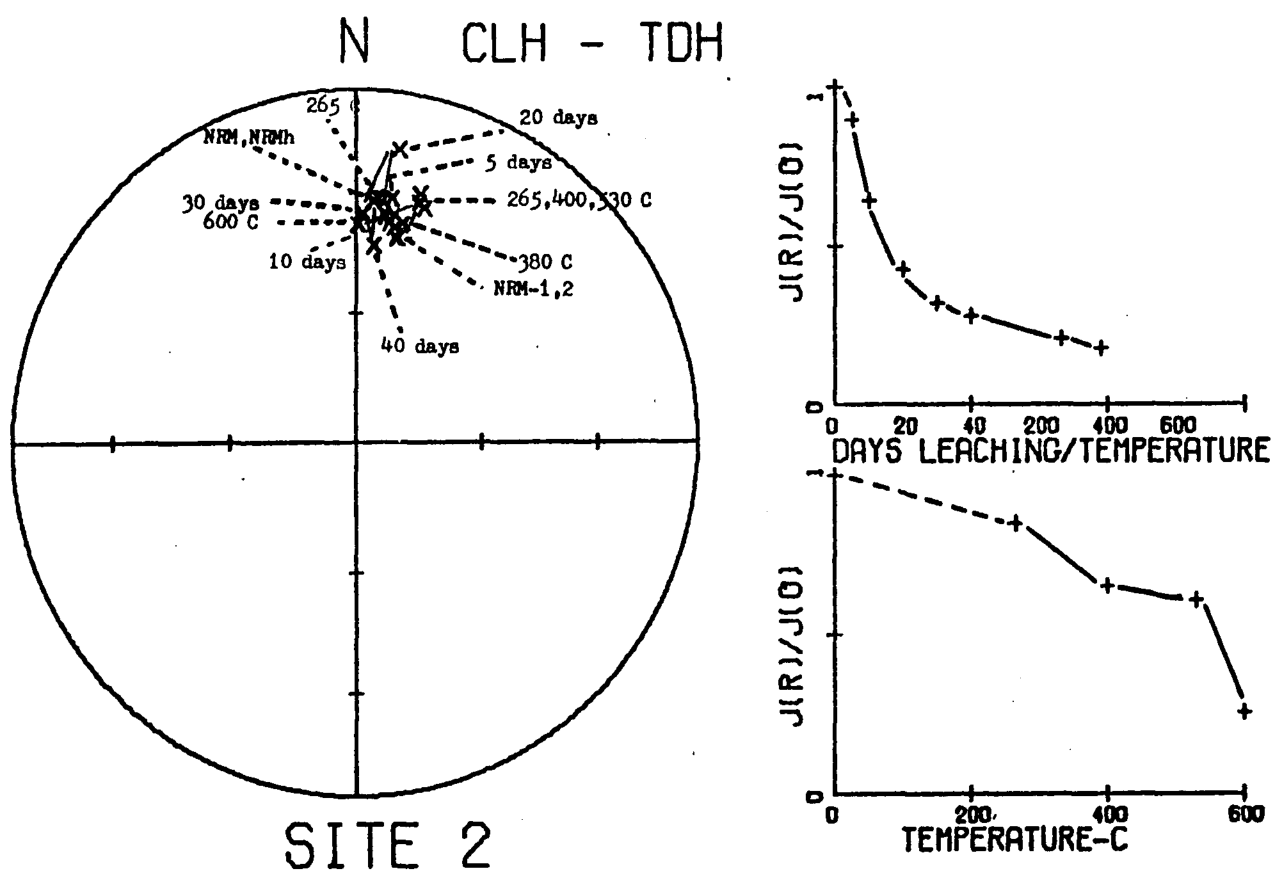


Figure 8. Sample 2-1, an example of Group I behavior.

Triassic normal direction. Through progressive heatings of 265° C, 400° C, 530° C, and 600° C, the direction moves slightly closer to Triassic normal direction. Viewing the relative intensity plot, by 530° C, J_r/J_o is 61 % and at 600° C, J_r/J_o is 26 %. Apparently there was a sizable amount of magnetite responsible for this specimen's original remanence seen ($<$ 35 %). Since only 26 % of J_r/J_o remains at 600° C, a recognizable amount of hematite is present, but not the quantity that was to be expected.

Figure 9 shows sample 18-1 (specimens 18-1-1, 18-1-2), also considered Group I. For the leached specimen, NRM and NRMh are near Triassic normal direction. By quickly observing the directions through the leaching and ending thermal treatment, at 5, 10, 20, 30, and 40 days, and 265° C and 380° C, little deviation occurs except for a minor excursion at 20 days. Viewing the relative intensity plot, by 20 days, 9 % of J_r/J_o is left. This remains a rather stable endpoint for the additional demagnetization.

For the thermally treated specimen, again NRM-1 and NRM-2 are near Triassic normal direction. With 423° C and 560° C, the direction moves slightly toward a better Triassic normal direction. On the relative intensity plot, by 560° C, 30 % of J_r/J_o remains. This intensity of magnetization remaining is due to a mixture of hematite and magnetite. Again, a lower amount of hematite than was expected is responsible for the NRM seen in this specimen.

The remaining plots of Group I specimens are in Appendix 10 for inspection with the magnetizations listed with all the

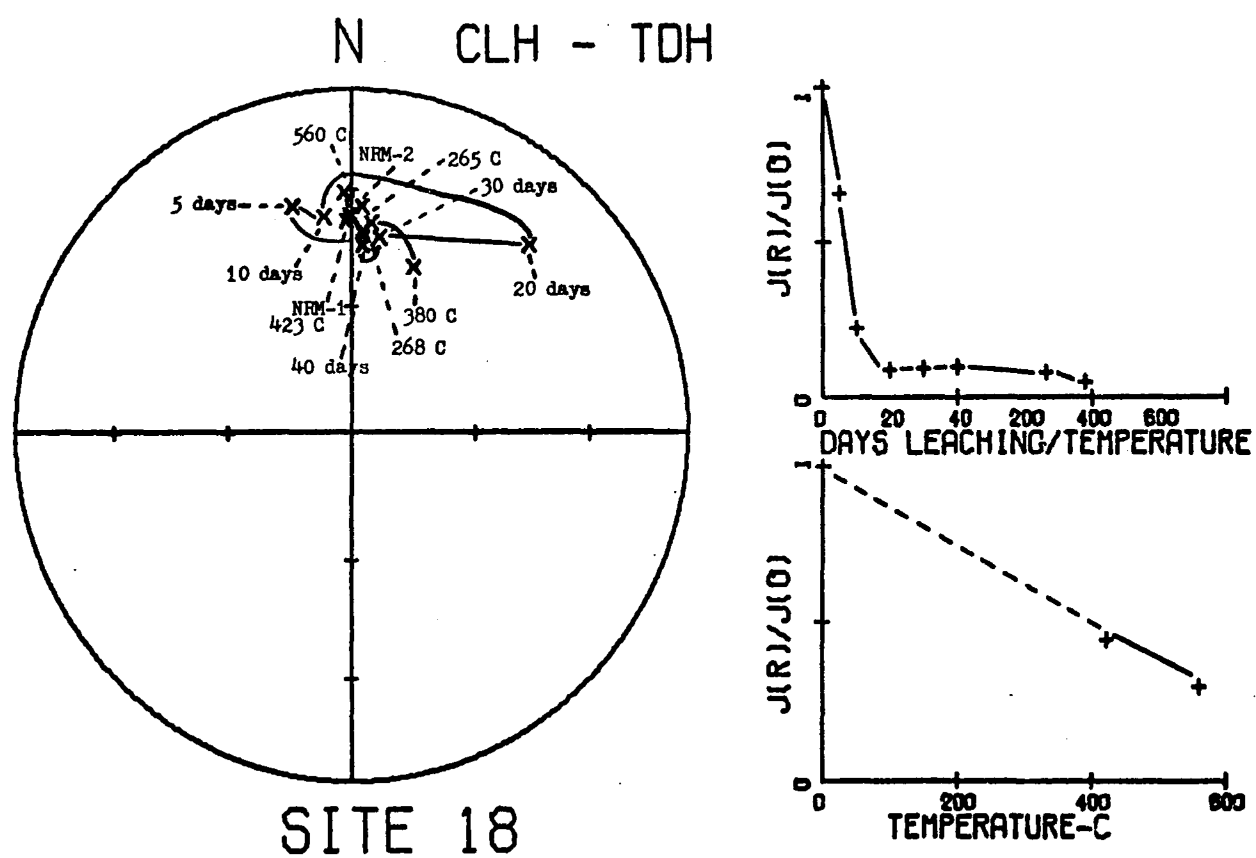


Figure 9. Sample 18-1, an example of Group I behavior.

samples in Appendix 1. Important observations to make while viewing these plots might include the following. For the thermally treated specimens, if anomalous directions occur above 530° C that are accompanied by very low relative intensities ($<$ 10 %), most likely the remanence has been wiped out at this point, and the very little remanence remaining is not enough to suggest any reliable conclusions about the direction.

A special note may also be made about sample 1-3. The leaching seemed to have virtually no effect on the intensity of this sample. In addition, the remanence was essentially due to magnetite. At 530° C, 34 % of J_r/J_o remains, but at 600° C, 2 % remains. The 600° C treatment was accompanied by an anomalous direction change. The sample was a red mudstone, but perhaps the remanence was due to a TRM acquired through a lightning strike. The specimens had enormous intensities at NRM (87.9 and 80.5 10^{-6} emu/gr). The question that remains is why didn't the acid effectively attack the magnetite present?

Group II had leached specimens whose NRM was near Triassic normal or reversed, and with increased leaching time the direction appeared to migrate or flip antipodal to the initial NRM direction. For some specimens the motion was oscillatory. Figures 10 and 11 show red bed samples 7-1 and 2-2.

In Figure 10 (7-1), the leached specimen has NRM and NRMh direction near Triassic reversed. At 5 days, the direction moves to a normal declination, and at 10 and 20 days, the specimen continues

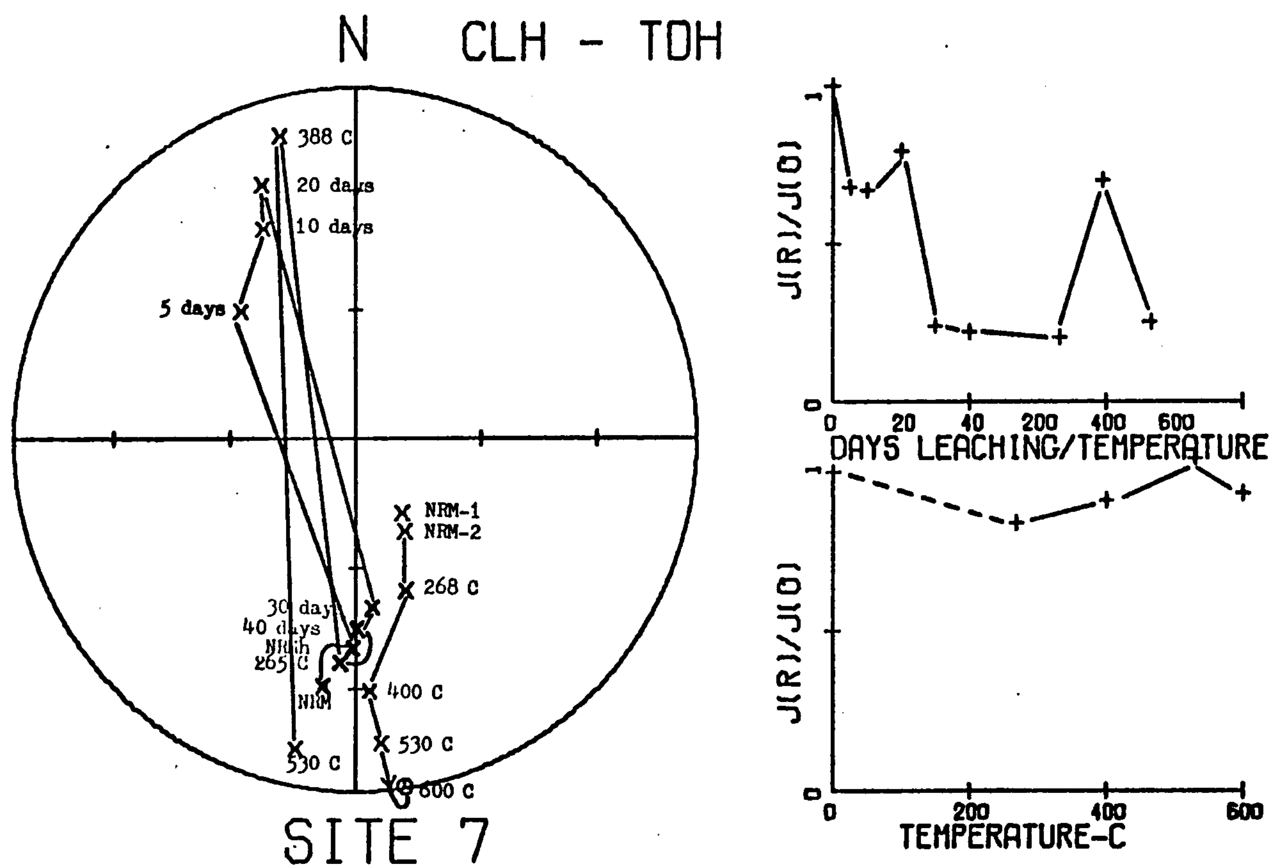


Figure 10. Sample 7-1, an example of Group II behavior.

its migration northward. At 30, 40 days, and 265° C, the direction returns to reversed declination, near Triassic reversed direction. For the 388° C treatment, the direction flips back to normal. Finally, at 530° C, the declination returns to reversed. The inclination never becomes reversed, however. (See Results, Part III for how the reversed samples from the magnetic stratigraphy carried out at this site seemed to have a very hard overprint as shown by the directions at 625° C). Viewing the relative intensity plot, there seems to be two apparent plateaus or peaks in intensity, one near 70 %, corresponding to the normal directions, and one near 25 %, corresponding to the reversed directions.

For the thermally treated specimen, NRM-1 and NRM-2 have reversed declinations. At heating stages of 268° C, 400° C, 530° C, and 600° C, the direction moves progressively to a better Triassic reversed direction. At 600° C, the inclination even becomes reversed. Viewing the relative intensity plot, there is little to no intensity loss, and at 530° C, there is an increase from J_o. Apparently, a normally directed vector has been removed, leaving a better Triassic reversed direction.

As shown by this sample, and the chemical leaching history, perhaps there were two Triassic polarities recorded, and at 5, 10, 20 days, and 388° C, the normal vector component is dominant.

Figure 11 shows sample 2-2, also a Group II example. Viewing the leached specimen, NRM and NRMh appeared between Triassic normal and present-day directions. At 5 days, however, the

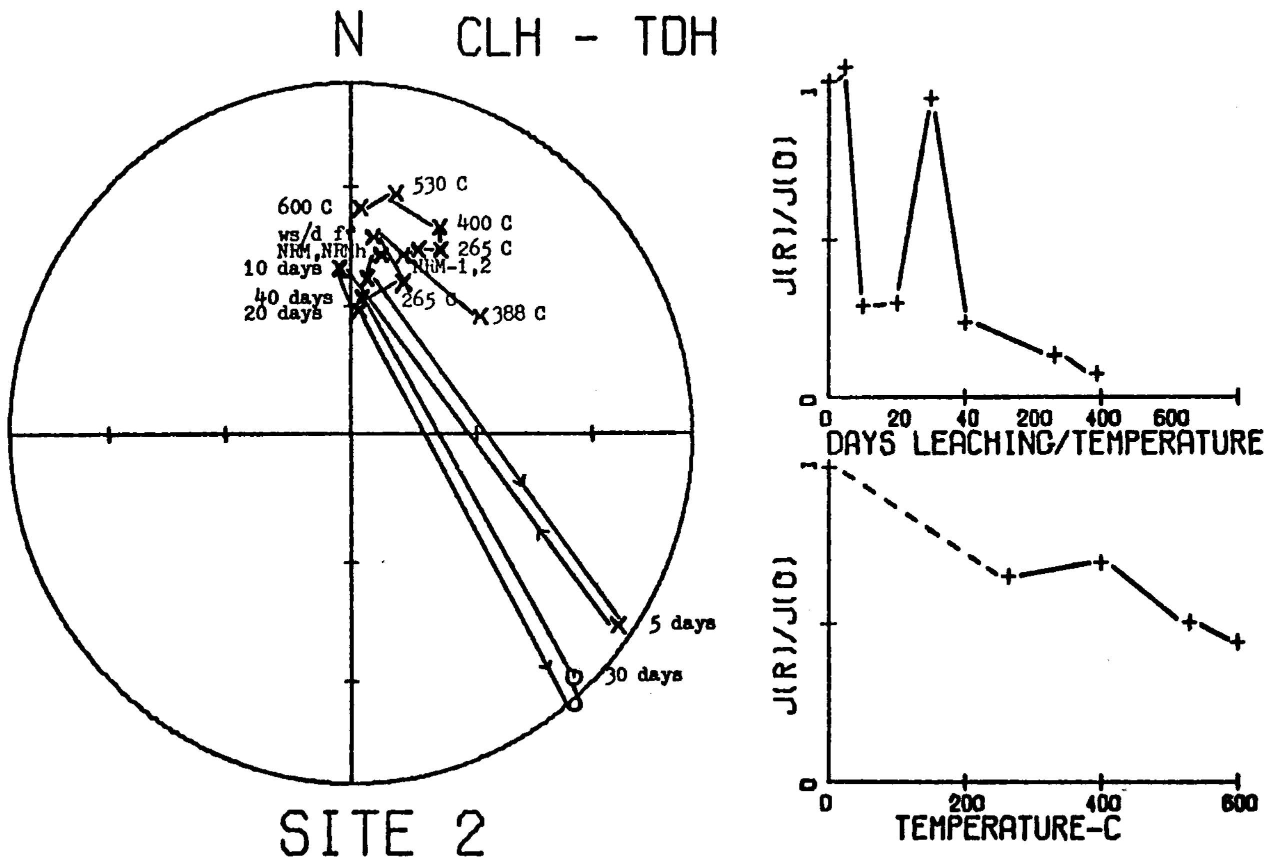


Figure 11. Sample 2-2, an example of Group II behavior.

declination flips to reversed. At 10 and 20 days of leaching, the direction again returns to normal, until at 30 days, the direction flips back to reversed, this time the inclination also becoming reversed. For the remaining treatment at 40 days, 265° C and 388° C, the direction returns to near the NRM direction. On the relative intensity plot, the direction flip at 5 and 30 days was accompanied by a return or enormous increase in intensity back to that originally measured.

For the thermally treated specimen, NRM-1 and NRM-2 were nearly identical and, again, between Triassic normal and present-day directions. At temperatures of 265° C, 400° C, 530° C, and 600° C, the direction moves progressively to a better Triassic normal direction. On the relative intensity plot, by 600° C, 44 % of the J_o remains, so that a considerable amount of hematite is responsible for the original remanence measured. Again, as shown by this sample, the recording of two Triassic polarities must be considered.

The plots of the remaining Group II samples are included in Appendix 11 for inspection. It may be pointed out that when directions appeared to flip antipodal, inclinations did not always become reversed and declinations were not always 180° apart. This may be due to a third component of magnetization present that had not been removed, perhaps present-day (Group III specimens may substantiate this!). In any event, the direction change was almost always accompanied by an increase in intensity.

Group III had leached specimens whose NRM was near Triassic normal or reversed, and with increased leaching time, the Triassic direction appeared to be leached out, leaving a residual present-day direction. Figures 12 and 13 show samples 5-6 (specimens 5-6-4, 5-6-3) and 15-5-2-3, both red beds that were examples of this group.

In Figure 12, the leached specimen at NRM and NRMh has Triassic reversed directions with a reversed declination and inclination. At 5 days, the inclination becomes normal and at 15 days, the direction moves northward. After 25 and 35 days of leaching, the direction hovers around present-day field direction. With the thermal treatment of 265° C, soaking the sample with water and allowing it to dry in field-free space (ws/d ff), and the final heating, 388° C, little change from present-day occurs. Viewing the relative intensity plot, by 15 days, 14 % of J_o remains, and this is a stable endpoint reached for the additional treatment.

For the thermally treated specimen, NRM-1, NRM-2, and NRM-3 are near Triassic reversed direction. With increasing temperatures of 265° C, 400° C, 530° C, and 600° C, the direction moves progressively to a better Triassic reversed direction. On the relative intensity plot, little to no intensity is loss, and an increase at 265° C indicates removal of a normally directed vector (most likely, present-day!).

Figure 13 shows sample 15-5-2-3, also an example of Group III. Following the leached specimen, at NRM and NRMh, the direction appears to lie between Triassic normal and present-day. After the

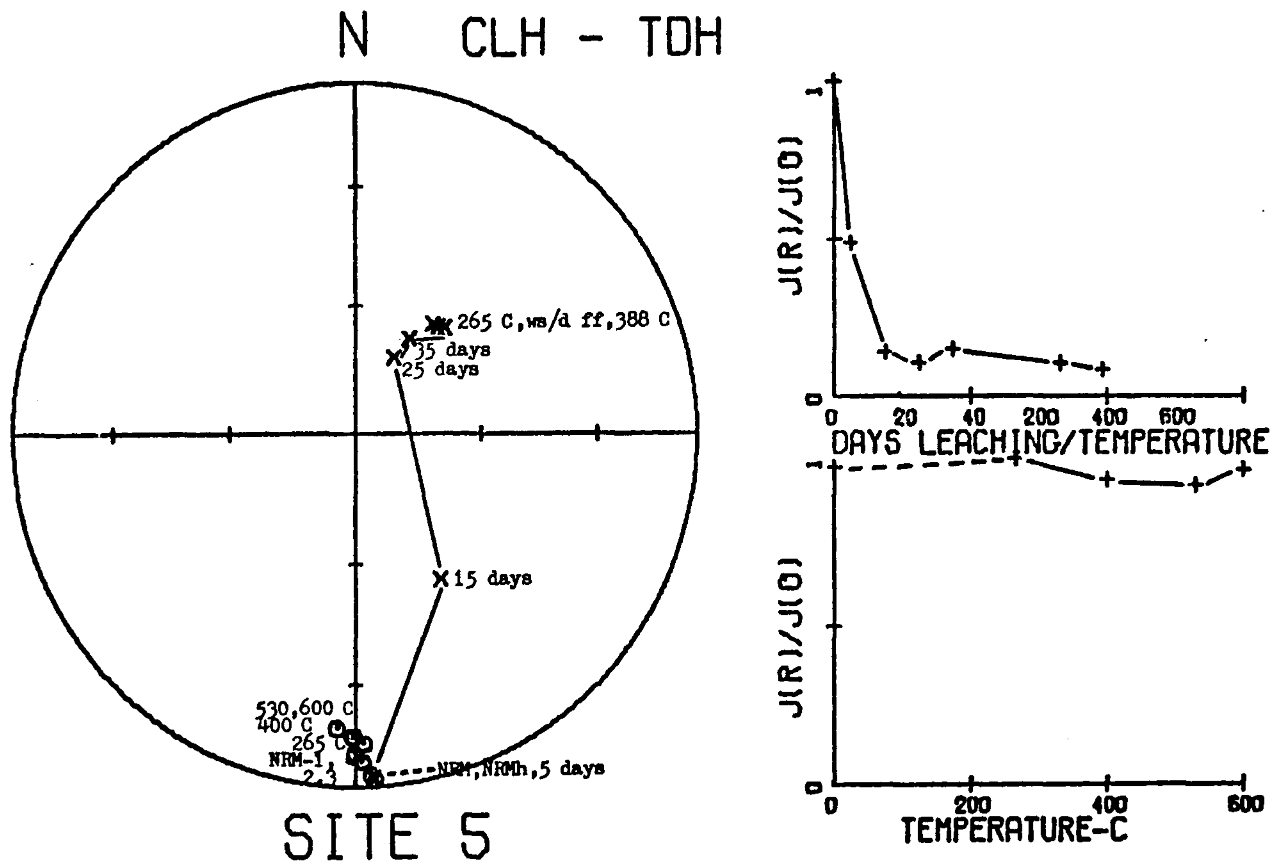


Figure 12. Sample 5-6, an example of Group III behavior.

leaching at 5, 10, 20, 30, 40 days, and thermal treatment of 265° C and 388° C, the residual direction seems to hover at present-day. For the relative intensity plot, by 20 days, 9 % of J_o is left, and this seems to be a stable endpoint for the remaining treatment.

For the thermally demagnetized specimen, NRM-1 and NRM-2 are near Triassic normal direction. With stepwise heating of 268° C, 400° C, 530° C, and 600° C, the direction moves progressively to a better Triassic normal position. By 530° C, on the relative intensity plot, 81 % of J_o remains. Apparently, a sizable amount of magnetite and/or hematite is responsible for the original remanence measured. It will be seen in Part II of the Results, that many specimens like this one cored from the stratigraphic control (15-5) behaved in a similar manner. The plots of the remaining Group III specimens are available for inspection in Appendix 12.

Not all specimens fit neatly into Groups I, II, or III. Some specimens seemed to be a combination of Groups II and III. Some were questionable as to whether the movement of the direction was antipodal or to a present-day position, or whether there was movement at all. Finally, some specimens seemed to yield completely anomalous results.

Figures 14 and 15 show samples 15-5-1-3 and 15-5-2-1 which seemed to be both Groups II and III. In Figure 14, for the leached specimen, the NRM direction is near Triassic normal. At 20 days the declination flips to reversed direction. Accompanying this is an increase in intensity. During the remaining treatment, the

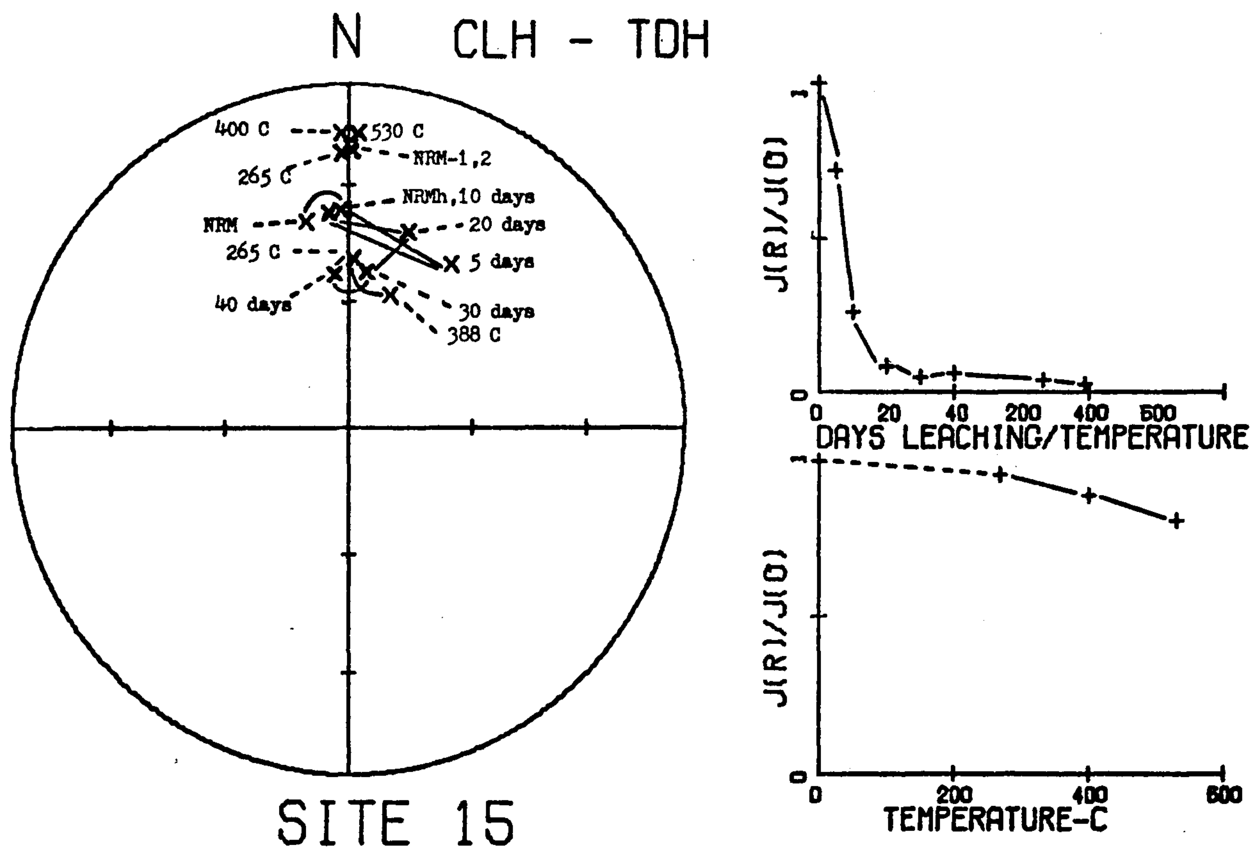


Figure 13. Sample 15-5-2-3, an example of Group III behavior.

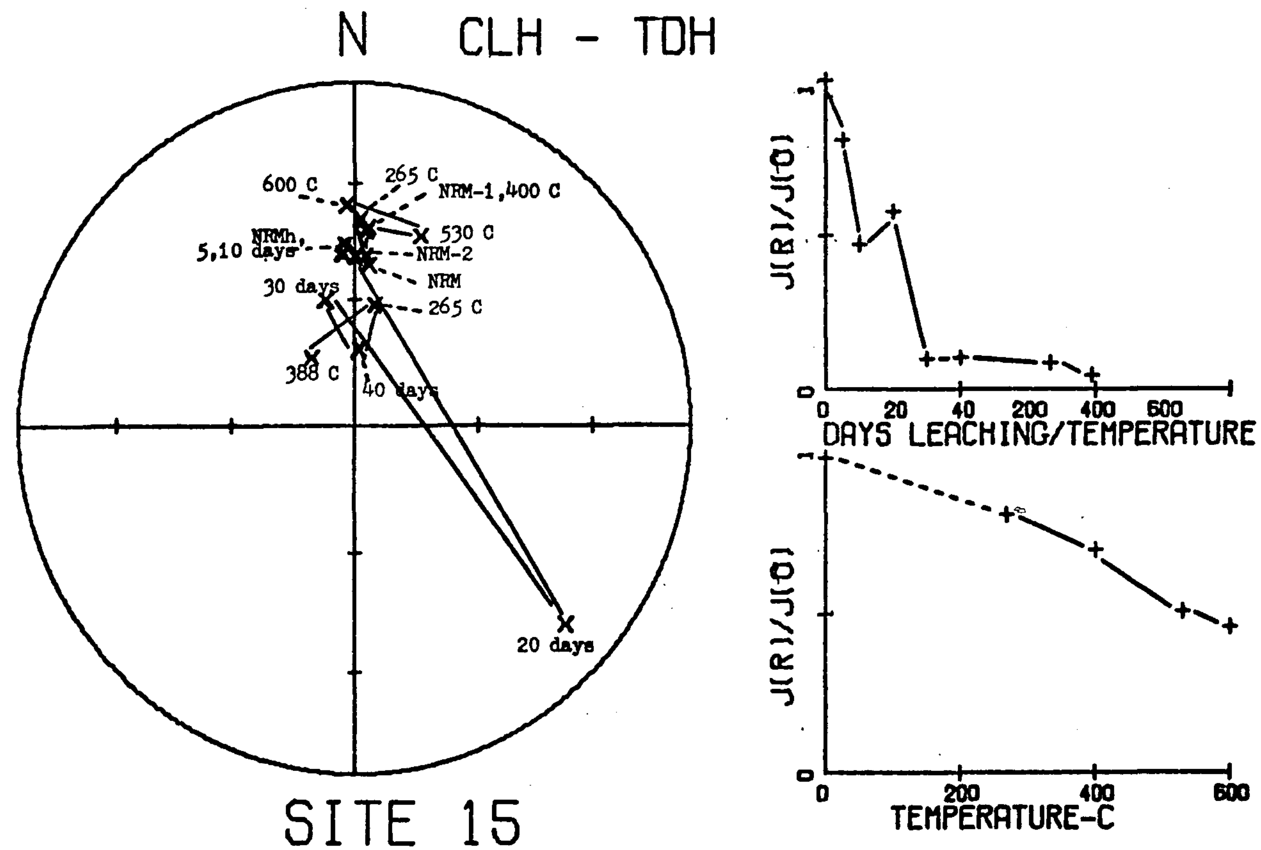


Figure 14. Sample 15-5-1-3, an example showing a combination of of Group II and III behavior.

direction returns to normal and the residual direction appears near present-day.

In Figure 15, again for the leached specimen, NRM is near Triassic normal. During leaching, the direction flips at 30 days, also accompanied by an increase in intensity. The remaining treatment returns the direction to normal, and the residual direction at the end of the treatment is near present-day. Both of these specimens (Figures 14 and 15) were from the stratigraphic control and will be discussed further in Results, Part II.

The plots of the samples that were questionable as to placing them into Groups I, II, or III are found in Appendix 13. Again, for these samples, it was impossible to tell whether the movement in the directions observed were toward an antipodal or present-day position, or whether there was any real movement at all. (Site 6 samples most likely are Group III, movement toward present-day. Site 5 samples, collected 2 km from site 6 clearly displayed this motion). The plots of the samples whose results seemed completely anomalous are found in Appendix 14.

In summary, the thermally treated specimens seemed well-behaved with directions moving progressively toward a better Triassic normal or reversed position. In contrast, the chemically leached specimens seemed to differentiate into three groups (see Figure 7).

Part II. Stratigraphic control on demagnetization procedures

This segment of the study applies both chemical leaching and thermal demagnetization procedures to a confined stratigraphic

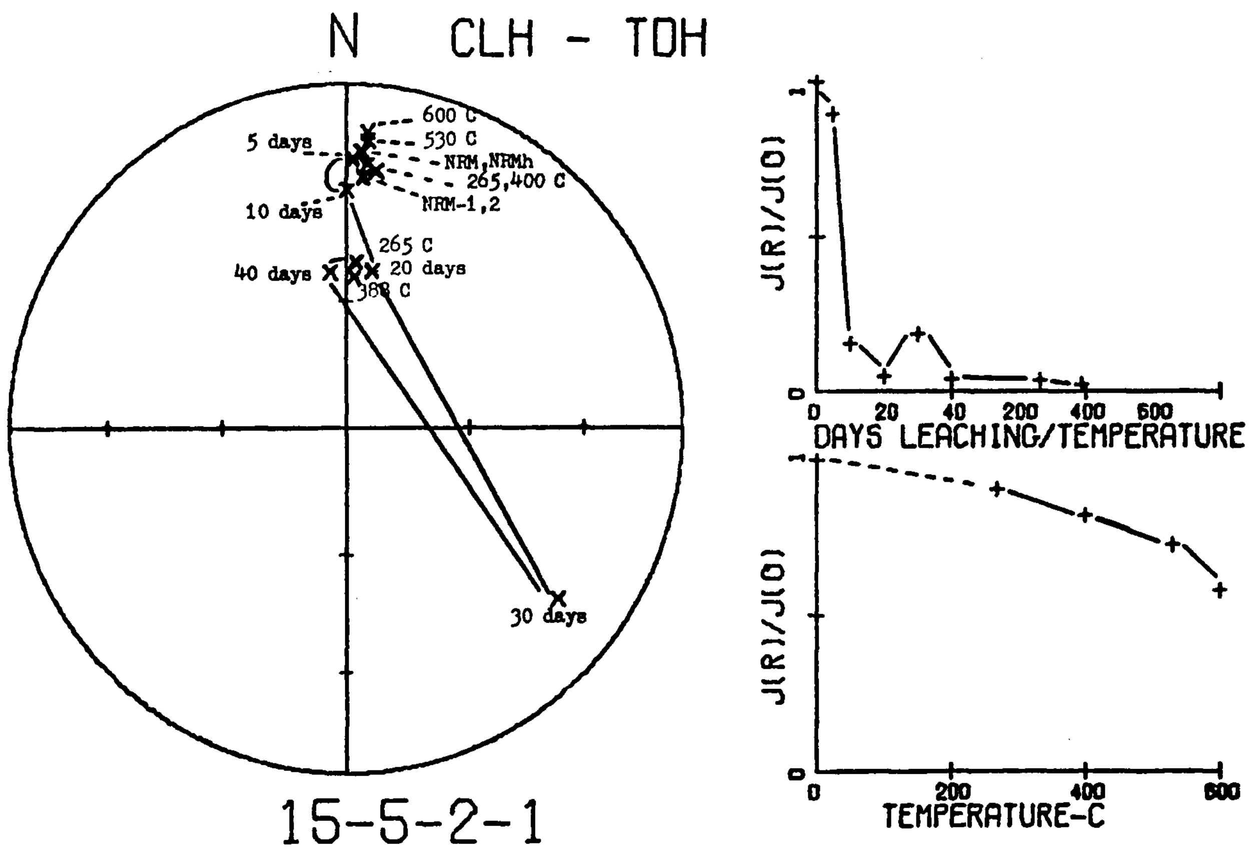


Figure 15. Sample 15-5-2-1, an example showing a combination of Groups II and III behavior.

section to note variations in intensities and directions through the two procedures. The section (sample 15-5) was a red bed sequence from the Brunswick Fm representing 33 cm of stratigraphic section. Four cores were taken from each of four bedding planes with each core being divided into two specimens. One was used for the chemical leaching and the other core for the thermal demagnetization. This totalled thirty-one specimens from the control. (Refer to Appendix 2 for the nomenclature of the specimens.)

Chemical leaching and thermal demagnetization procedures remained the same as for the first part of this study. The results are presented in Figures 16 - 23. (Also see Appendix 3 for a listing of each specimen by demagnetization; interpreted polarity; magnetic direction, both corrected and uncorrected for bedding attitudes; relative intensity; and J (10^{-6} emu/gr).) Each figure presents demagnetization results for two of the four cores taken from bedding plane 1, 2, 3, or 4. The stereonet shows the directions during demagnetization for the two specimens, one chemically leached and the other, thermally demagnetized. (The directions plotted are uncorrected for bedding attitude.) The relative intensity plots are below each stereonet. Intensities for all specimens ranged from 4.13 - 25.0 (10^{-6} emu/gr). Results from stratigraphically, older to younger, bedding planes 1 to 4, are given below.

Refer to Figures 16 and 17 for results from the oldest time horizon, bedding plane 1. For the chemically leached specimens, (one from each double core) the NRM and NRMh directions appeared

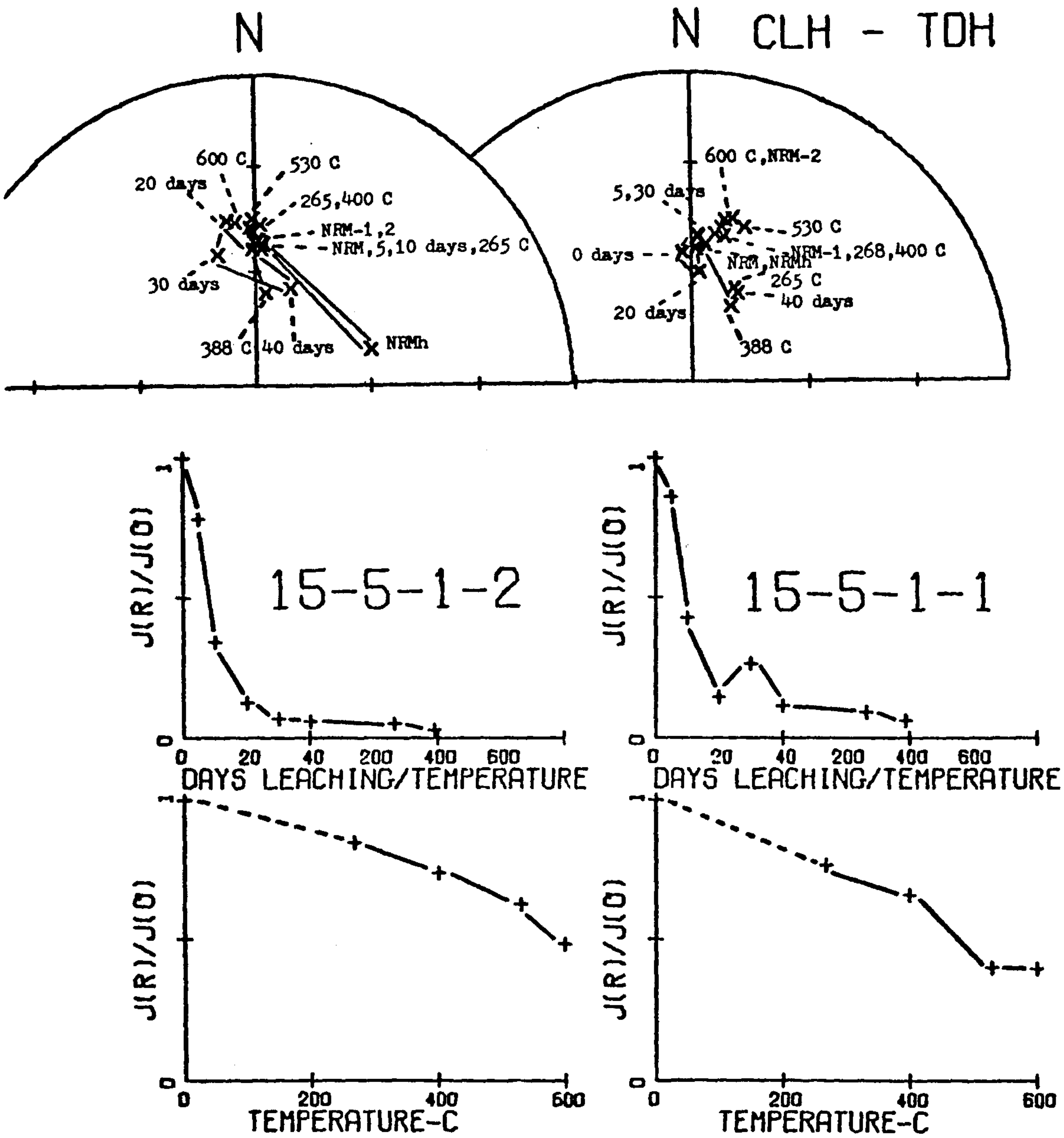


Figure 16. Samples 15-5-1-1 and 15-5-1-2 from bedding plane 1 of stratigraphic control.

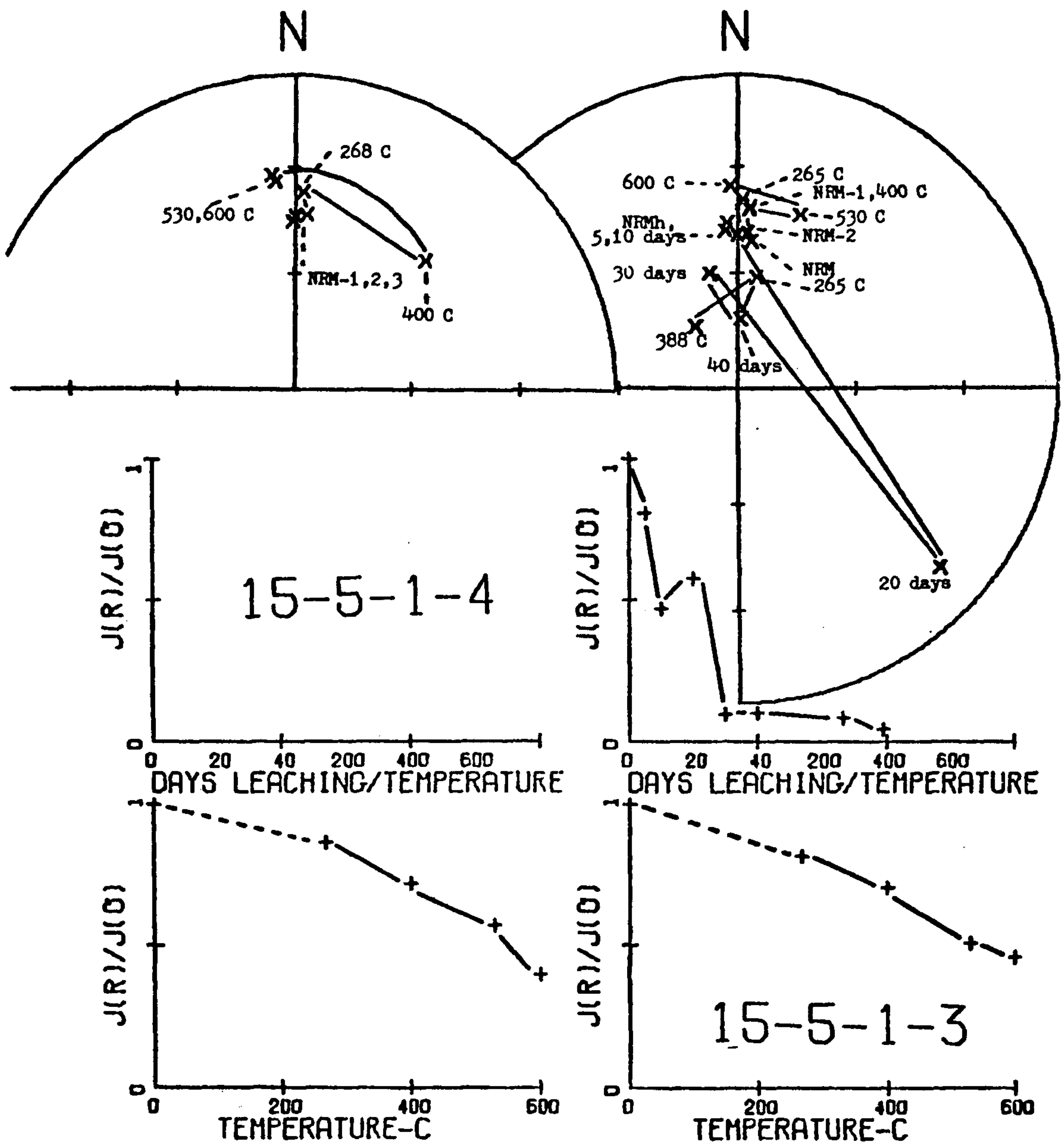


Figure 17. Samples 15-5-1-3 and 15-5-1-4 from bedding plane 1 of stratigraphic control.

intermediate between Triassic normal and present-day (stratigraphic column 4 had no leached specimen for it was too short). For stratigraphic columns 1 and 2 (Figure 16), the directions migrated slightly toward present-day with increased leaching. (A seemingly inexplainable increase in intensity occurred in the leached specimen from column 1 at 30 days.) These could be considered Group III specimens (see Figure 7 from Part I of results). In the leached specimen from column 3 (Figure 17), the direction flipped to a reversed declination at 20 days. Accompanying this was an increase in intensity. This specimen could be considered Group II. After 40 days of leaching, all specimens had less than 12 % J_r/J_o.

For the thermally treated specimens from bedding plane 1, the NRM directions were intermediate between Triassic normal and present-day. With progressive heating, the directions moved slightly toward Triassic normal, but still appeared intermediate between Triassic normal and present-day. At 600° C, at least 40 % of the J_r/J_o remained in all cores. A sizable amount of hematite was responsible for the original NRM measured.

Results of bedding plane 2 are shown in Figures 18 and 19. For the chemical leached specimens, NRM and NRMh appear intermediate between Triassic normal and present-day. After 40 days of leaching, all specimens had moved to a present-day position. This would indicate Group III specimens again. A noticable flip occurred for the leached specimen from column 1 at 30 days, leaving it with a reversed declination. This was accompanied by an increase in inten-

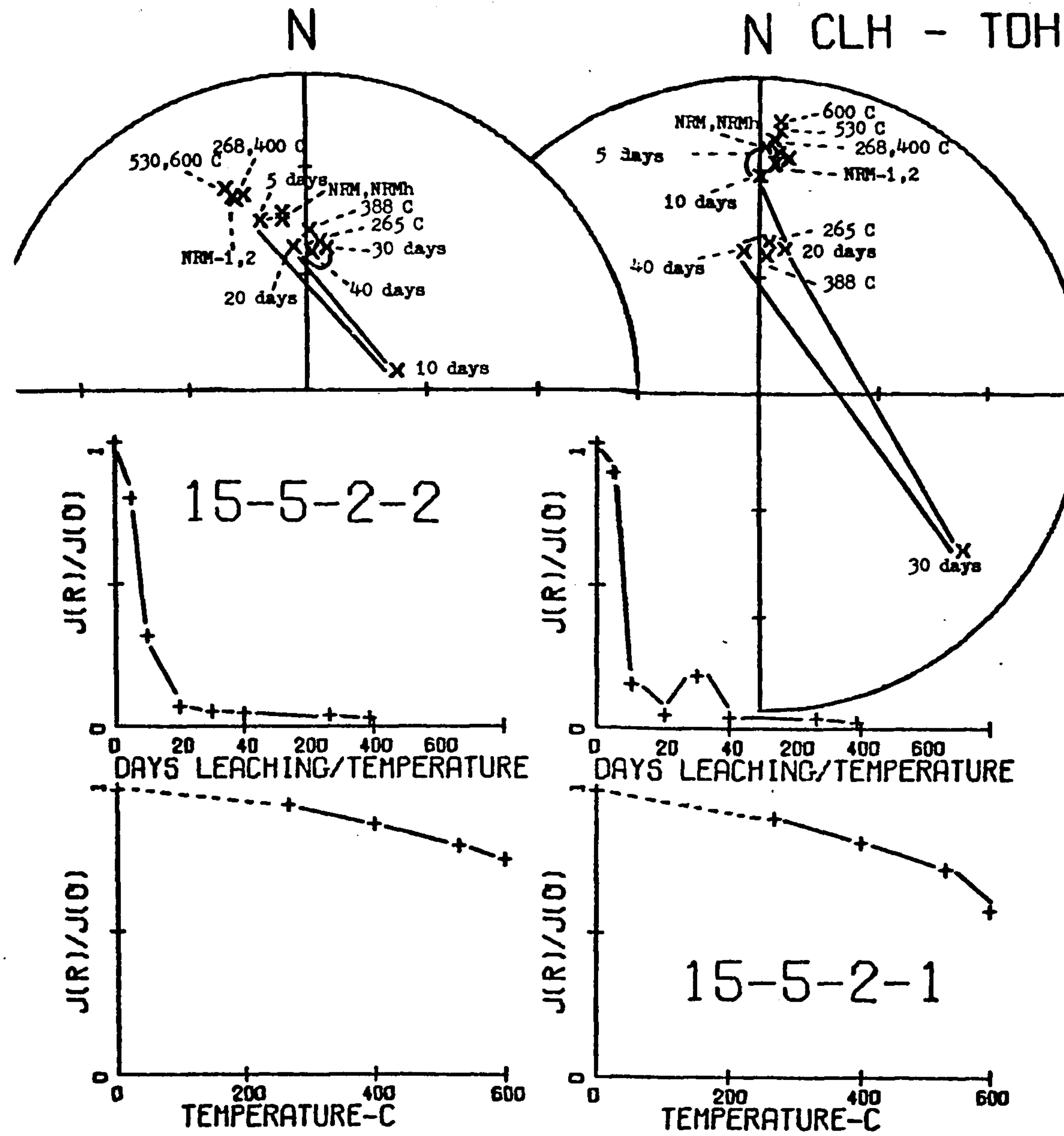


Figure 18. Samples 15-5-2-1 and 15-5-2-2 from bedding plane 2 of stratigraphic control.

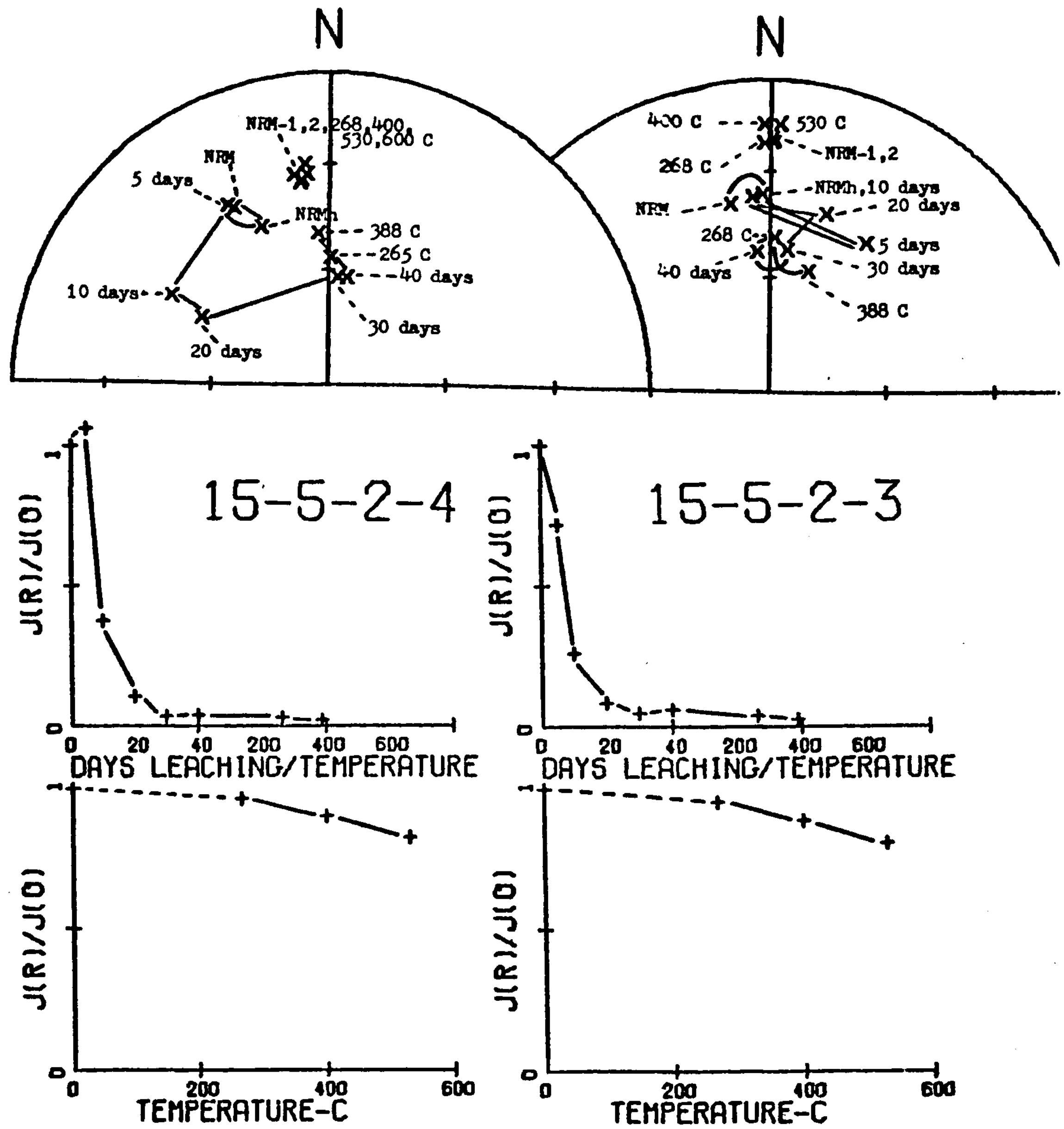


Figure 19. Samples 15-5-2-3 and 15-5-2-4 from bedding plane 2 of stratigraphic control.

sity. This specimen would be regarded as Group II and III. Minor excursions in directions occurred for the leached specimens from columns 2 at 20 days and 4 at 10 and 20 days. These were not accompanied by increased intensities. After 40 days of leaching, only 6 % of J_r/J_o remained for the specimens.

For the thermally demagnetized specimens from bedding plane 2, NRM directions were near Triassic normal, and with increased heating, these moved closer to a Triassic normal direction. By 600° C, for all specimens, at least 53 % of J_r/J_o remained. Most of the original NRM measured was due to hematite.

Bedding plane 3 is represented in Figures 20 and 21. The NRM and NRMh directions of the chemically leached specimens were intermediate between Triassic normal and present-day. At 40 days of leaching, all the directions had moved closer to a present-day position. These would be considered Group III specimens. For all the leached specimens, by 40 days, less than 7 % of J_r/J_o remained.

There were excursions from this Group III behavior observed. For the leached specimen from column 1, at 388° C, after the leaching, the direction flipped to a reversed declination. Accompanying this was an increase in intensity. In the leached specimen from column 3, at 10 days, the declination reversed, and at 20 days, the declination returned to normal, although with a reversed inclination. The reversal in inclination at 20 days was accompanied by a plateau or leveling off in intensity. This behavior would be considered Group II.

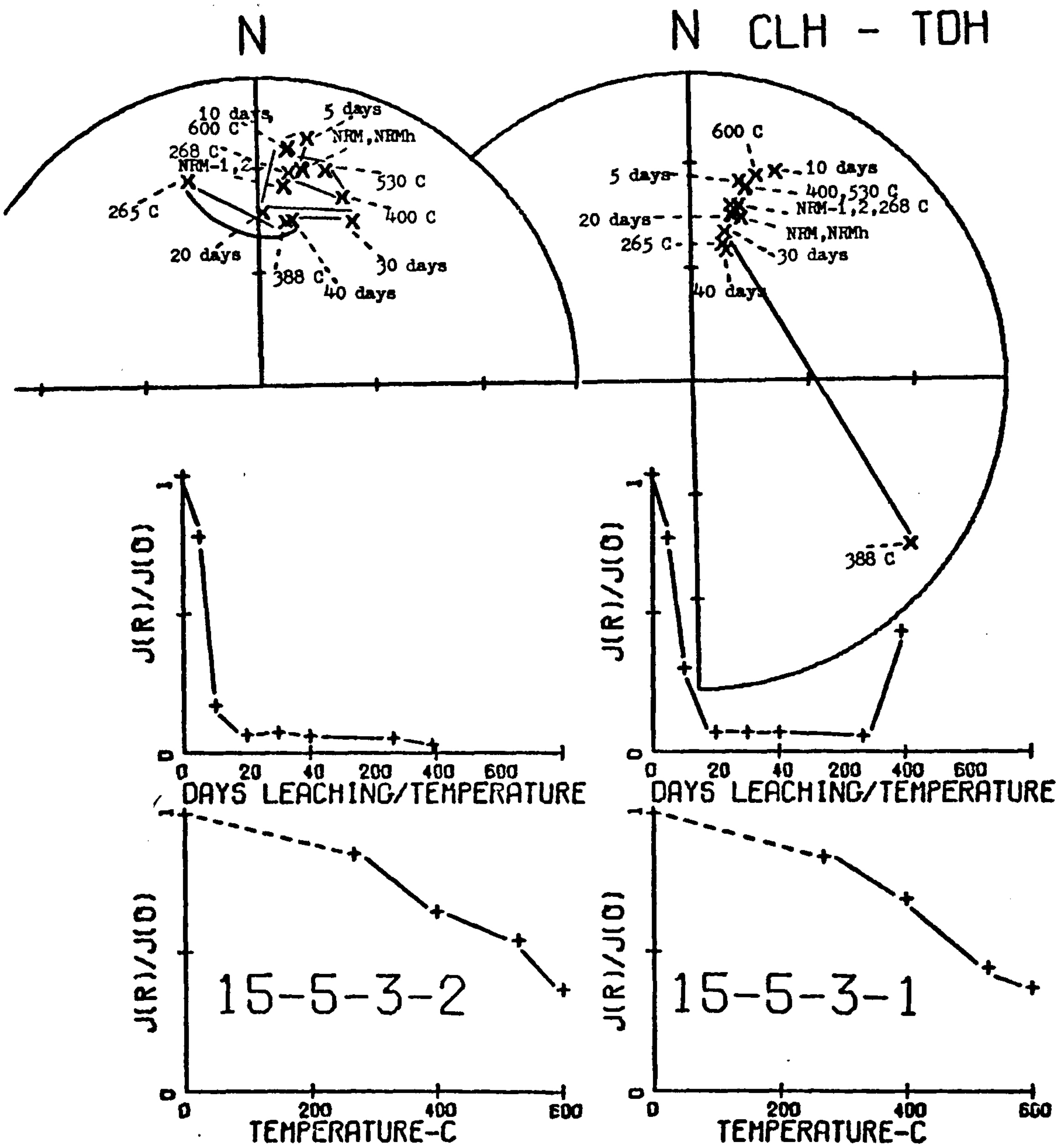


Figure 20. Samples 15-5-3-1 and 15-5-3-2 from bedding plane 3 of stratigraphic control.

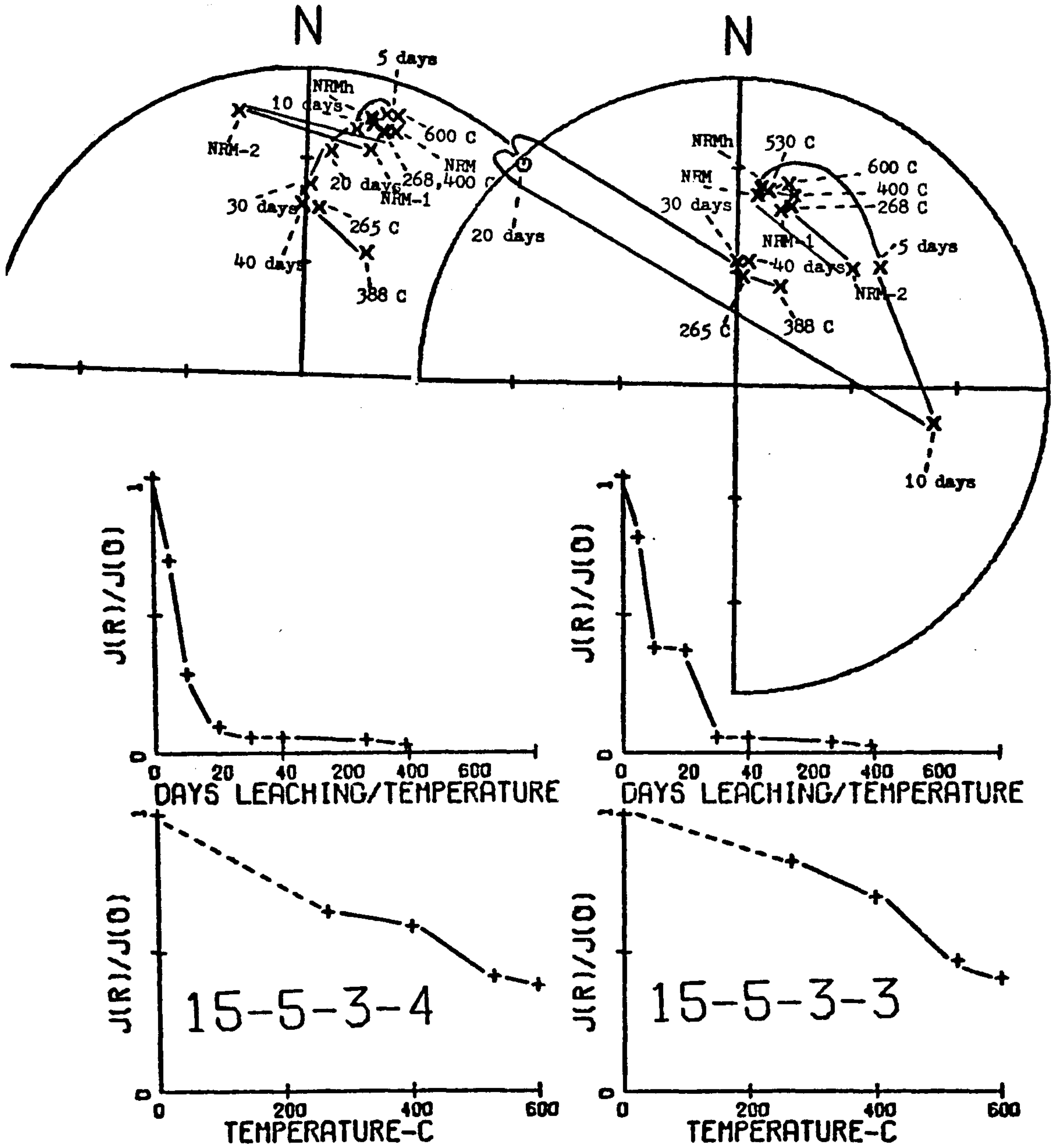


Figure 21. Samples 15-5-3-3 and 15-5-3-4 from bedding plane 3 of stratigraphic control.

For the thermally demagnetized specimens of bedding plane 3, NRM directions were near Triassic normal and with increased heating the directions moved progressively to a better Triassic normal position. Following the relative intensity plots, at least 37 % of J_r/J_o remained for all specimens at 600° C.

Bedding plane 4 is shown in Figures 22 and 23. For the chemically leached specimens, NRM and NRMh were near Triassic normal. At 5 days of leaching, two of the four specimens had disintegrated in the acid so measurements could not be made. The directions of the other two specimens, columns 2 and 3 moved little. After 5 days they also disintegrated in the acid and could not be measured. Apparently a sizable amount of $CaCO_3$ was present in bedding plane 4, most likely in the form of a cement.

The thermally demagnetized specimens from bedding plane 4 had NRM directions near Triassic normal. With increased temperatures to 600° C, the directions moved progressively to better Triassic position. Following the relative intensity plots, by 600° C, for all these specimens at least 76 % of J_r/J_o remained. Hematite was the principal carrier of remanence in the original NRM measured.

Summarizing the results of Part II which was intended as a magnetostratigraphic control for chemical and thermal demagnetizations, it was observed as seen in Part I, both Group II and III behaviors were recorded for the leached specimens. Most of the leached specimens appeared to migrate toward present-day position by the end of the 40 days. Figure 24 includes all these directions

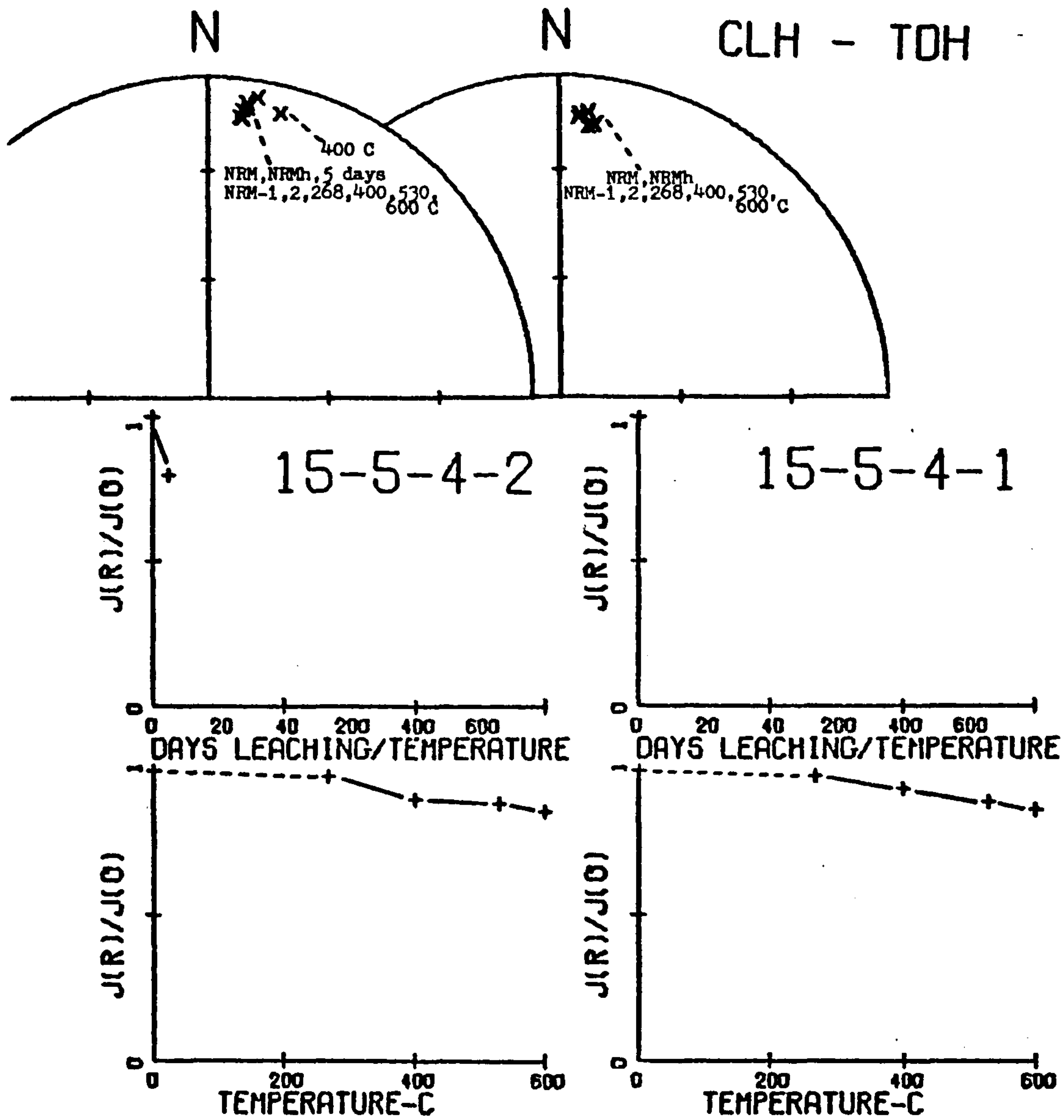


Figure 22. Samples 15-5-4-1 and 15-5-4-2 from bedding plane 4 of stratigraphic control.

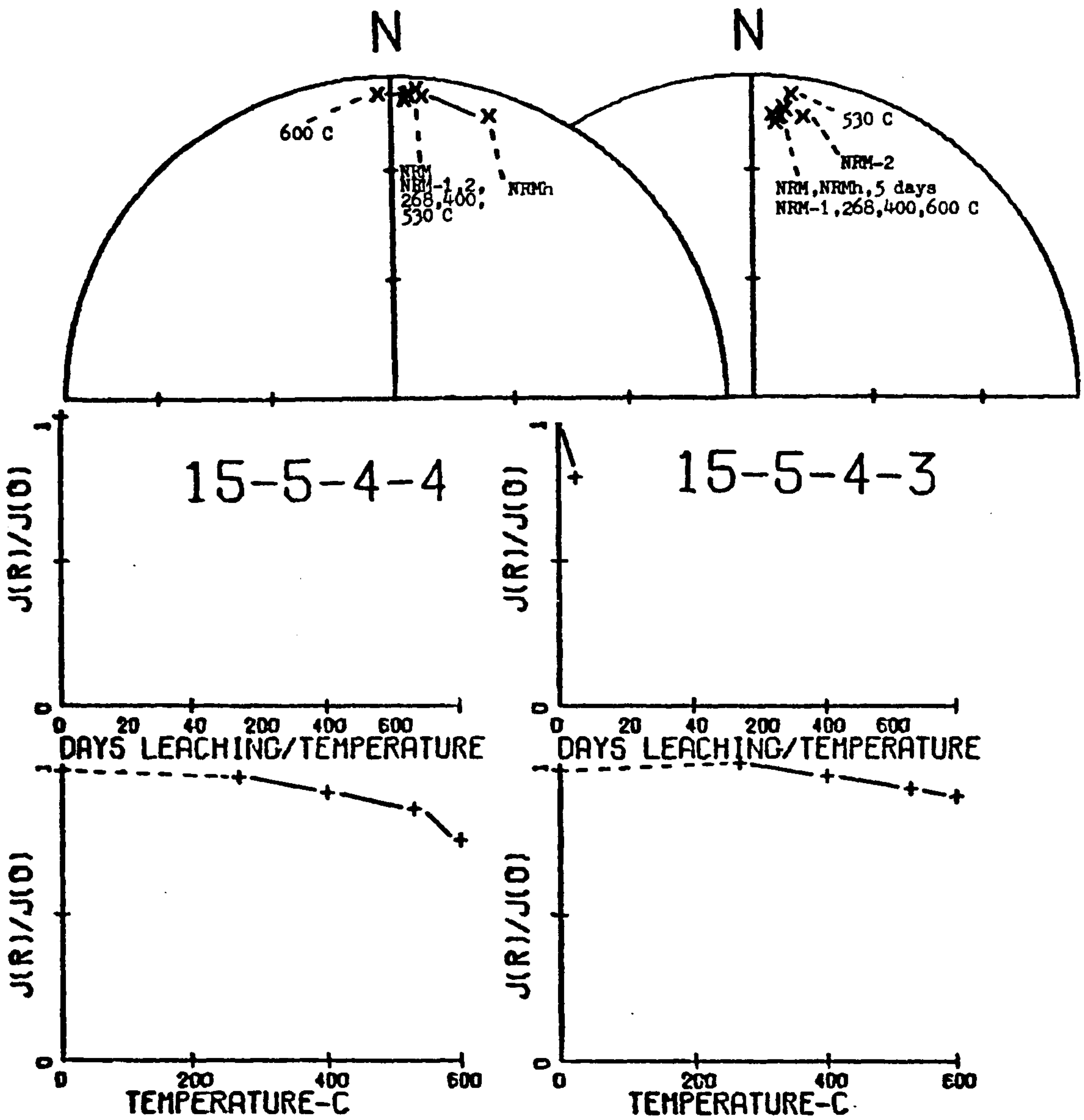


Figure 23. Samples 15-5-4-3 and 15-5-4-4 from bedding plane 4 of stratigraphic control.

at 40 days and their resulting mean direction (N=11). Table 3 lists the samples, directions, and Fisher statistics for these 40 day measurements. The mean direction had an inclination of 51.7°. This certainly, at least, is intermediate between Triassic normal and present-day. (Present-day inclination is about 71°.) α_{95} was 8.1, well within the range of acceptibility (usually the maximum of α_{95} allowable for reliability is 10).

Recall also that at least one specimen from each bedding plane flipped to a reversed declination during the leaching. This was always accompanied by an increase in intensity which indicates the removal of an oppositely directed vector. Not every specimen from each bedding plane exhibited this Group II behavior, the possible recording of two polarities. If all the specimens from the same bedding plane and therefore time horizon did not display this dual polarity behavior, either the cores acquired their remanence at different times, over a longer time, or the measurements during leaching missed the flip.

Despite this Group II behavior, the leached specimens from all the bedding planes in this stratigraphic control seemed to behave rather uniformly under leaching. This included a smooth decrease in intensity, along with Group III behavior. (By 30 days all specimens, with the exception of two, had less than 10 % J_r/J_o remaining.)

The thermally treated specimens from this stratigraphic control appeared well-behaved. NRM directions were near Triassic

TABLE 3. FISHER STATISTICS FROM CONTROL (15-5) AFTER 40 DAYS OF CHEMICAL LEACHING (N=11)

SAMPLE NUMBER	DECLINATION	INCLINATION
15-5-3-4-2	359.20	43.30
15-5-3-3-2	5.40	56.50
15-5-3-2-1	11.20	44.40
15-5-3-1-1	14.60	53.90
15-5-2-4-1	10.00	61.80
15-5-2-3-1	355.10	52.80
15-5-2-2-2	2.50	53.90
15-5-2-1-2	354.70	52.60
15-5-1-3-2	2.80	17.80
15-5-1-2-1	20.40	62.90
15-5-1-1-1	26.70	63.70

R=10.69749 Mean declination=6.36° Mean inclination=51.74°

α_{95}=8.06° σ=13.47° K=33.06

Pole latitude=80.51° N Pole longitude=140.4° E σp=7.50°

Site latitude=40.38° N Site longitude=74.92° W σm=10.99

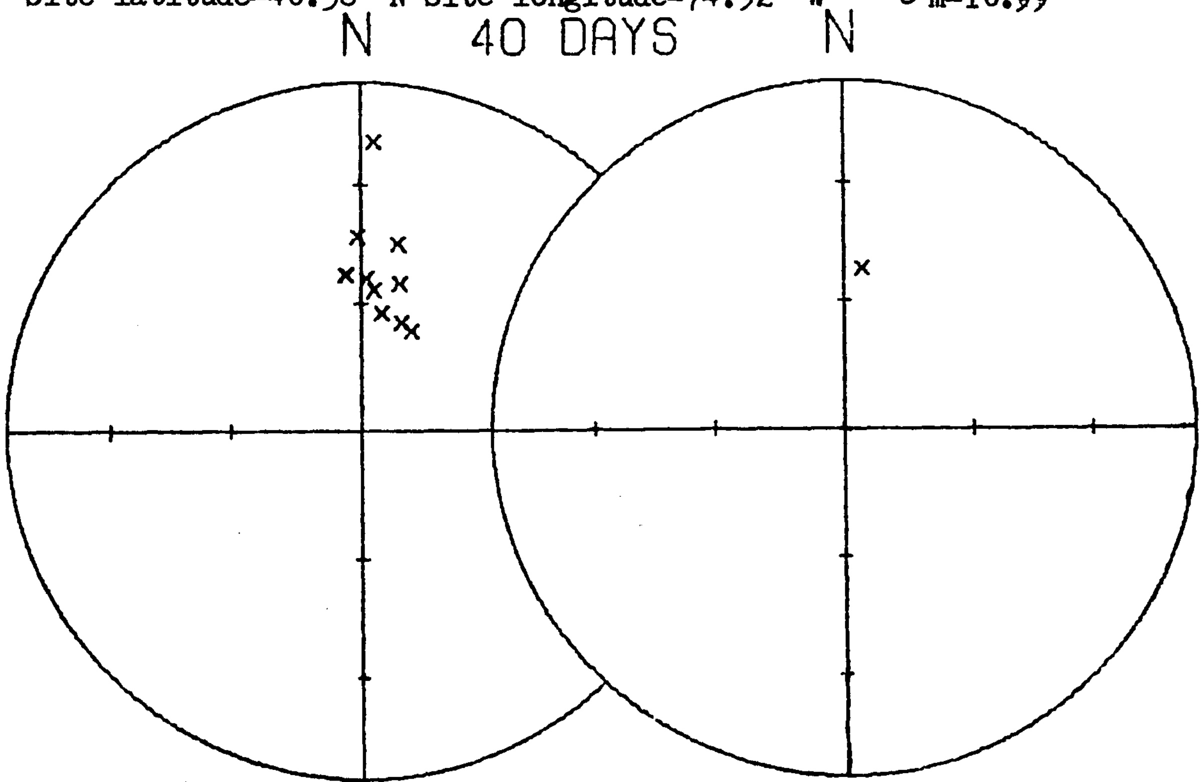


Figure 24. Directions and mean direction of stratigraphic control at 40 days of leaching (N=11).

normal, and with increased heating, the directions moved progressively to a better Triassic normal position. Figure 25 shows the resulting directions at 600° C and the resulting mean direction (N=16). Table 4 lists the specimens and directions along with the Fisher statistics. Note the mean had a direction of 1°, 26.9°, whereas Beck (1965) found a mean of 359.5°, 23° for Pennsylvania diabase units. α_{95} for these site 15 measurements was 8.4, also quite well within the acceptibility range. Again, for the thermally treated specimens from this confined stratigraphic control, all specimens appeared to behave rather uniformly.

Part III. Magnetic stratigraphy

Stratigraphic sections from three areas within the basin were sampled in an attempt to further establish the magnetic stratigraphy of the basin. The formations sampled included the Brunswick at sites 5 and 6, and the Stockton at site 9. At site 5, the Brunswick graded into the Lockatong Formation. Sampling also included the Stockton Formation at site 7, and the quartz conglomerate facies of the Brunswick Formation, the Hammer Creek Formation, at site 24.

Sites 5, 6, and 9

Site 5, along with sites 6 and 9 which were separated more or less on strike from site 5 by a few kilometers, proved to be an extremely successful sampling area. At site 5, a total of 63 specimens were measured and stepwise thermally demagnetized. This site consisted of red shales and siltstones of the Brunswick Formation which graded into a blue-gray argillite and, finally, a buff-

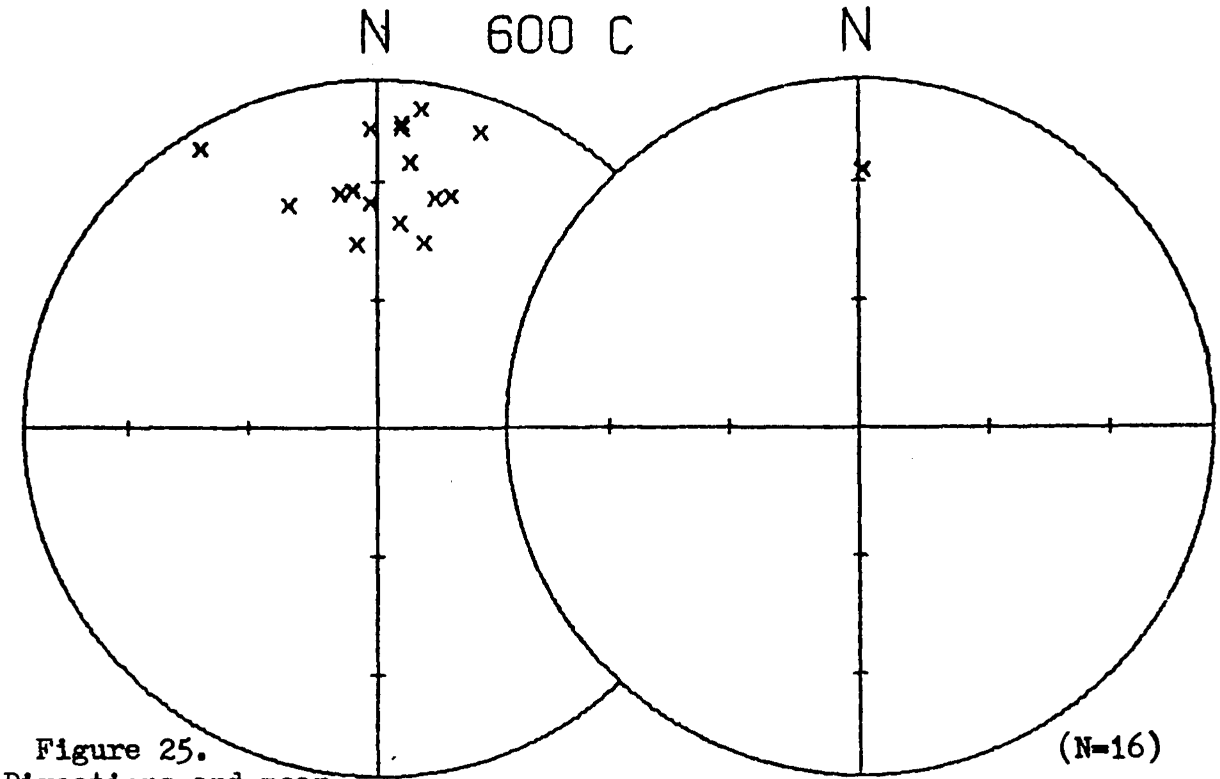


Figure 25.
Directions and mean
direction of stratigraphic control at 600° C.

SITE 15

TABLE 4. FISHER STATISTICS FROM CONTROL (15-5) AFTER 600° C
THERMAL TREATMENT (N=16)

SAMPLE NUMBER	DECLINATION	INCLINATION
15-5-4-4-2	327.90	6.00
15-5-4-3-1	6.10	40.40
15-5-4-2-1	7.80	8.50
15-5-4-1-2	4.50	13.20
15-5-3-4-1	18.90	11.30
15-5-3-3-1	14.10	32.50
15-5-3-2-2	6.90	24.00
15-5-3-1-2	17.50	30.90
15-5-2-4-2	350.90	32.60
15-5-2-3-2	358.70	15.20
15-5-2-2-1	338.50	31.90
15-5-2-1-1	4.40	14.50
15-5-1-4-1	354.00	32.00
15-5-1-3-1	358.10	35.70
15-5-1-2-2	353.40	45.90
15-5-1-1-2	13.90	44.50

R=15.26007 Mean declination=1.00° Mean inclination=26.86°

α_{95}=8.40° δ=17.49° K =20.27 δp=4.96° δm=9.12°

Pole lat.=63.82° N Pole long.=107.3° E

Site lat.=40.38° N Site long.=74.92° W

colored, fine-grained sandstone, both of the Lockatong Formation. Samples were taken at approximately 1.2 m intervals and represented almost 75 m of section.

The magnetization directions for these specimens were plotted as red beds or non-red beds on separate equal-area stereonets for each demagnetization level. These plots include Figures 26 and 28 and remain uncorrected for bedding attitudes. Figure 26 shows the red beds through levels of NRM, 407° C, 555° C, and the final heating temperature, 555° C or 610° C. A typical demagnetization curve and accompanying direction plot of one red bed sample, 5-C-1, is shown in Figure 27. Also recall Appendix 5 which includes the magnetic direction and relative intensity of each sample from site 5 through stepwise thermal demagnetization.

In addition to the red beds sampled, nine non-red bed specimens, consisting of blue-gray argillites and buff-colored sandstones were sampled in section E (youngest or uppermost of sampled sections) at site 5. These specimens would be considered from the Lockatong Formation. Their magnetic directions through demagnetization are shown in Figure 28. A typical buff-colored sandstone demagnetization plot and curve is shown in Figure 29. None of the blue-gray argillite specimens were similar through demagnetization. For this reason, no specific example has been included.

For the red beds there are two separate sets of direction at NRM (see Figure 26). The first cluster occurs near the present-day field direction, and the second occurs near Triassic reversed. Many of the samples in this second cluster have reversed inclinations, but some still have normal inclinations. There are several specimens whose directions plot outside the clusters. J_{NRM} ranges from 0.923 - 35.393 (10^{-6} emu/gr) for these red beds. (Specimens at the lower range intensity gave anomalous directions after thermal demagnetization.) Those specimens with higher intensities tended to have reversed directions. (See Appendix 4 and 5.)

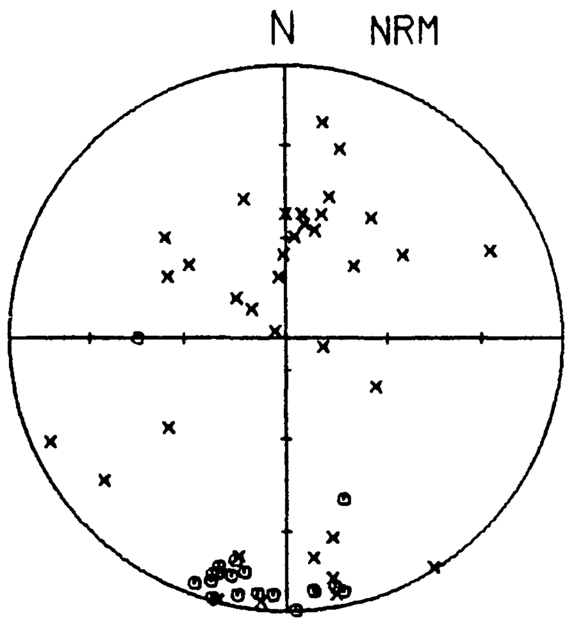
At 407° C, the clustering about present-day direction appears to have scattered. There are several samples that are near the Triassic normal field direction, but many specimens appear to have moved to a reversed declination. The reversed clustering has become denser and many of the once normal inclinations have become reversed.

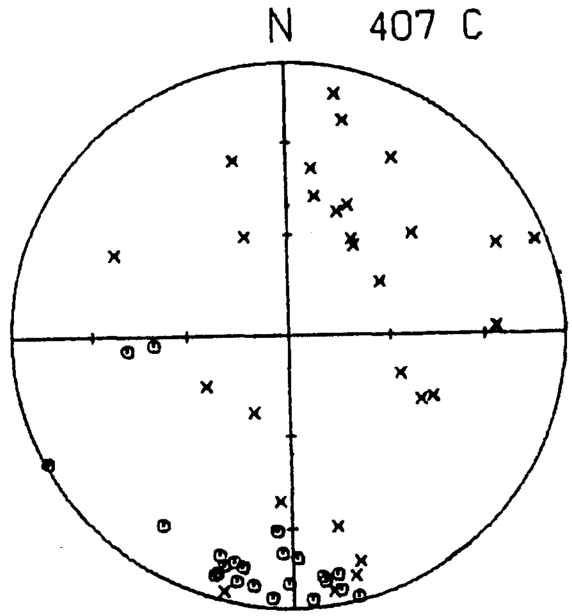
At 555° C, most of the present-day directions have moved closer to reversed declination and/or inclination. Two specimens retain a present-day direction, and it appears that there are possibly three specimens that have Triassic normal direction. There are several specimens with mixed or scattered directions that can not be classified as normal or reversed.

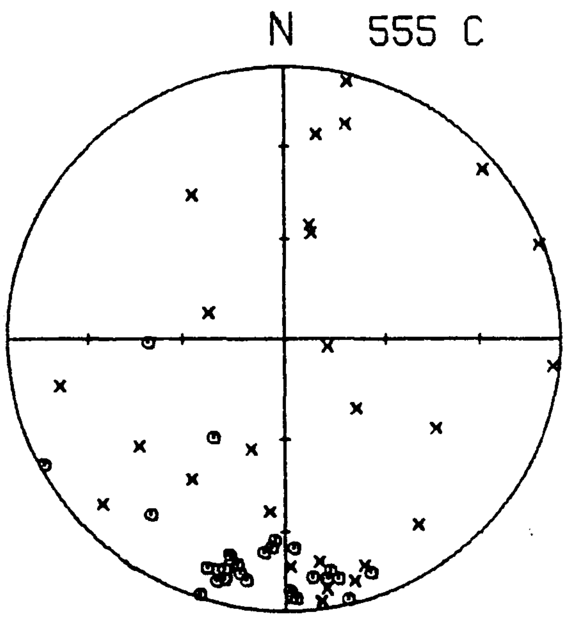
As mentioned, many of the specimens (about 2/3 of the total and especially those with mixed directions) were heated additionally to 610° C. Others that appeared to show good Triassic direction, either normal or reversed, were not heated above 555° C. The final plot is a combination of 555° C or 610° C and shows the direction at the highest temperature. Again, there is obvious

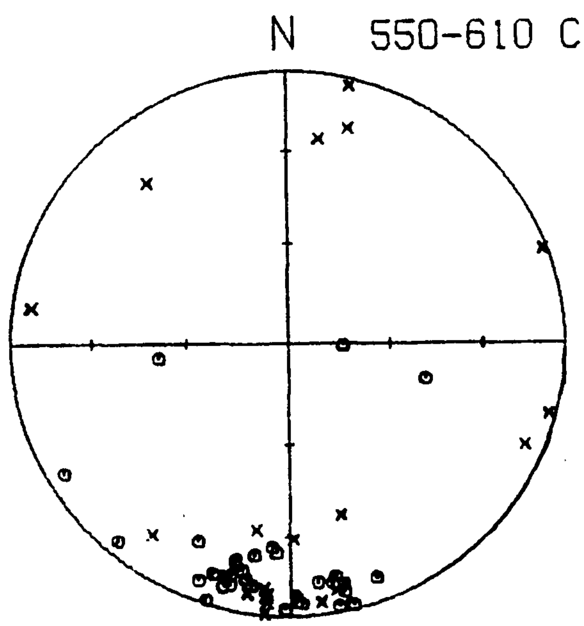
SITE 5

Figure 26. Site 5 red beds. Directions through thermal demagnetization.









clustering about the reversed Triassic direction, and most of the specimens have moved to reversed inclination directions. There are three samples that appear to have a Triassic normal direction. In addition, there are still some remaining specimens (less than ten) with mixed directions that can be considered neither normal or reversed. Most of the red bed specimens from site 5 are Triassic reversely magnetized with the exception of three that show Triassic normal direction. Obviously, most of this sampled stratigraphic section of 75 m at site 5 is reversely magnetized.

Figure 27 contains a stereonet and accompanying intensity curve with thermal demagnetization for a typical red bed (5-C-1). It can be seen that this reversely magnetized specimen initially shows a good reversed Triassic direction. As it is heated progressively to 407° C and 555° C, little change in direction occurs. Comparing the relative intensity curve through the heating, little to no intensity is lost in the initial heating to 407° C, and by 555° C, the specimen slightly exceeds its original intensity. Hematite (or maghemite) must be the primary carrier of remanence, for the Curie temperature of all other magnetic minerals is exceeded by 604° C. An oppositely directed normal component of magnetization (be it Triassic or present-day) has been removed by heating above the Curie temperature of the magnetic mineral(s) responsible for it. Most of the specimens behaved similarly and showed little to no loss in intensity. For some samples there was an increase of intensity with heating (see Appendix 5).

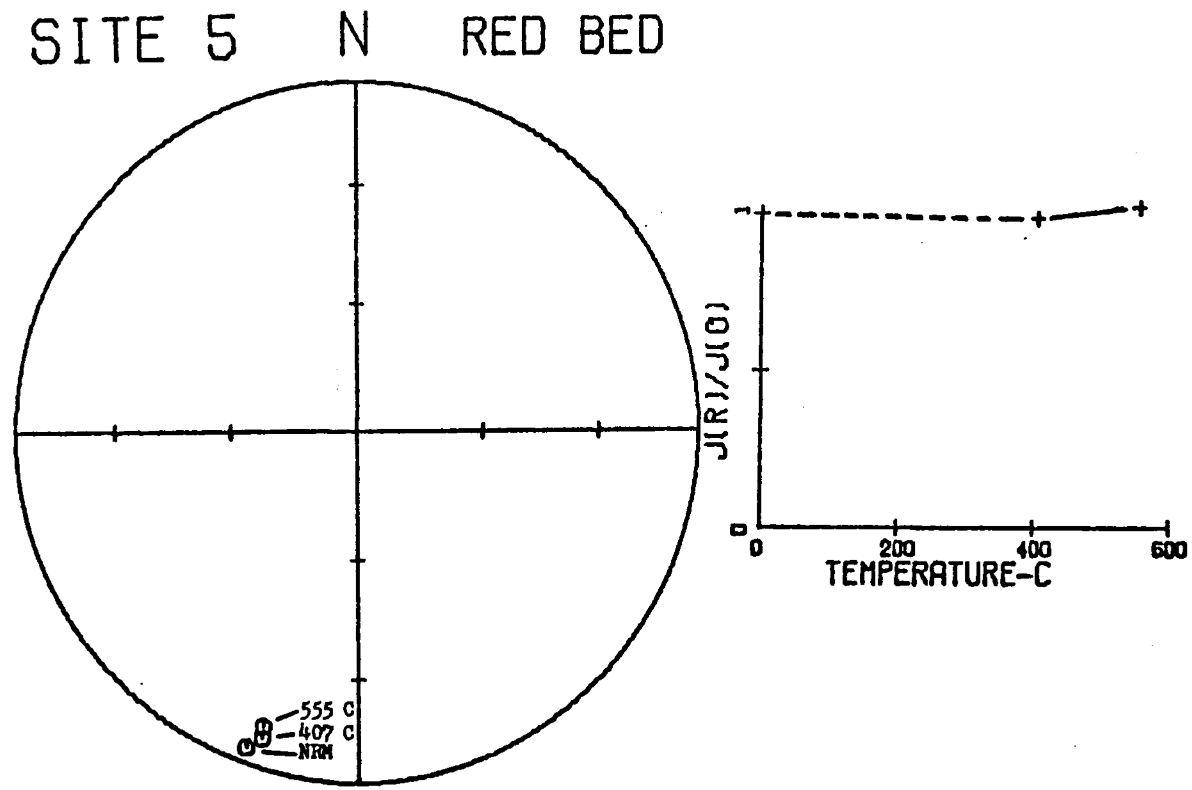


Figure 27. Typical demagntization of red bed from site 5.

In addition to the red beds, nine non-red bed specimens were also collected. The J_{NRM} of these specimens were low compared to the red beds and ranged from 0.522 - 2.177 (10^{-6} emu/gr) (see Appendix 4 and 5). In Figure 28, at NRM it can be seen that all but one specimen is clustered tightly about the present-day field direction. Upon heating, the directions scatter. One specimen could be considered reversely magnetized, but it still has a normal inclination.

Figure 29 shows a typical buff-colored sandstone demagnetization plot and intensity curve. This particular specimen (5-E-10P-1) initially has a large present-day overprint that, at progressive temperatures of 407° C and 555° C, is not removed. At 604° C, the direction becomes anomalous. In addition, very little of the original intensity remains. There appears to be very little hematite in this specimen judging by the amount of intensity remaining at the final heating stage. The magnetic minerals responsible for the remanence in this sample apparently have low Curie temperatures and associated blocking temperatures.

It can be said that either the non-red beds sampled at site 5 did not accurately record the Triassic paleofield or that thermal demagnetization was not the appropriate demagnetization treatment for these samples. Perhaps AF treatment would have had better resulting directions.

From site 6 (see Figure 5) a total of four samples were collected from 24.5 m of stratigraphic section. The specimens

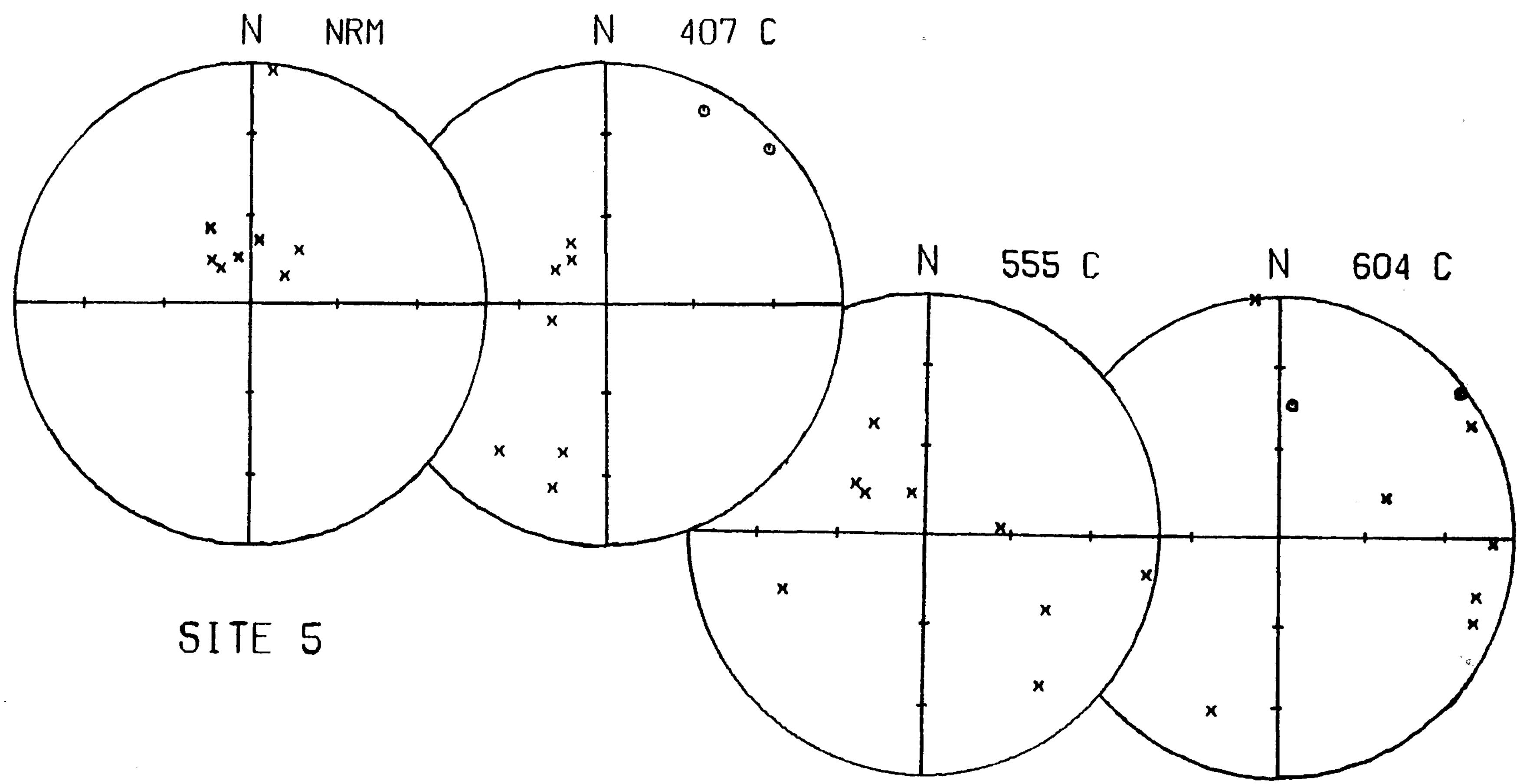


Figure 28. Site 5 non-red beds. Directions through thermal demagnetization.

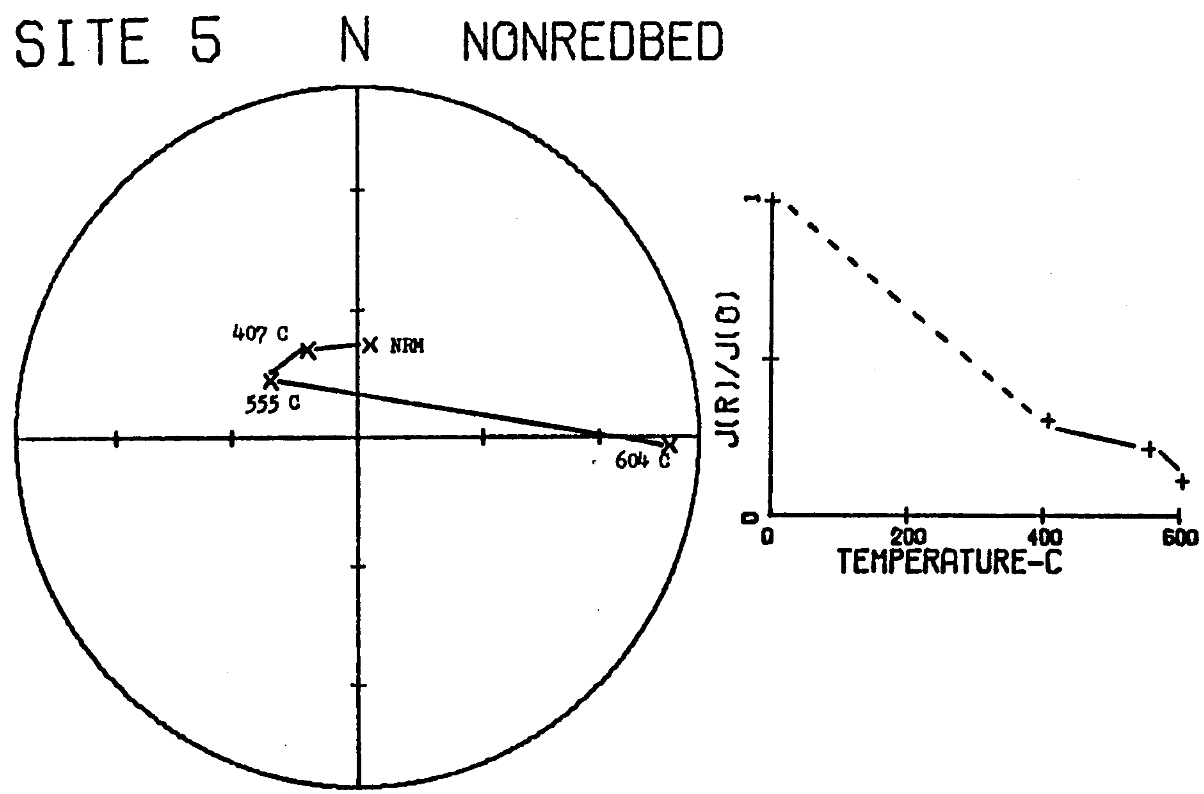


Figure 29. Demagnetization of non-red bed from site 5.

were red mudstones and shales of the Brunswick Formation. These specimens were measured at NRM and then thermally demagnetized at temperatures of 423° C and 550° C. NRM intensities for these samples ranged from 1.7 - 2.7 (10^{-6} emu/gr).

The directions resulting from these thermal heatings are shown in Figure 30. The directions remain uncorrected for bedding attitude. (Also see Appendix 4 and 5 for a listing of samples through demagnetization). At NRM, two of the four specimens have reversed declination initially, although their inclinations are normal. The other two specimens appear intermediate between Triassic normal and present-day direction. At 423° C, the two apparent reversed directions move progressively closer to a better reversed direction. The two intermediate directions appear to move slightly closer toward a reversed declination.

At 560° C, the two reversed directions have moved even closer to better reversed directions. One inclination, A-8, has even become reversed. The two once intermediate directions have moved to a reversed declination at least, but still appear mixed. Apparently, all these samples are reversed but have acquired a very hard overprint that remains even at 560° C.

Figures 31 and 32 are examples of a reversed specimen and a mixed specimen showing their direction and accompanying relative intensity plots through demagnetization temperatures. The reversed specimen moves toward a better reversed direction with each increase in temperature. Viewing the accompanying relative

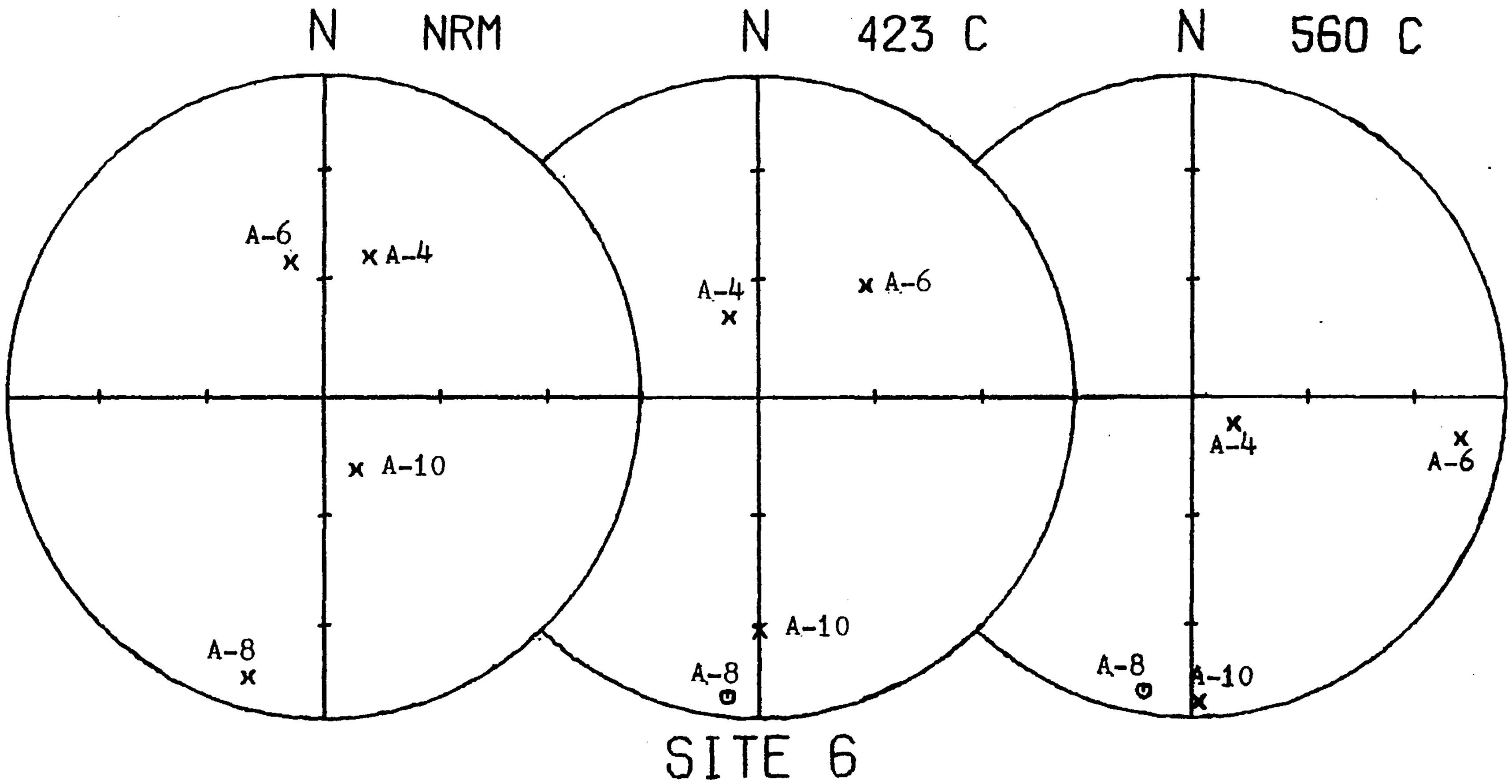


Figure 30. Site 6 red beds. Directions through thermal demagnetization.

intensity plot, both 423° C and 560° C show an increase in intensity relative to NRM. Obviously a normally directed vector has been removed, leaving a better reversed direction along with an increase in intensity.

Figure 32, the mixed specimen (neither Triassic normal or reversed) through demagnetization, shows at NRM, the direction very close to present-day. With each temperature increase, movement toward a reversed declination occurs. The direction remains apparently mixed at 560° C, most likely because of an acquired hard overprint, probably of present-day origin as shown by the NRM direction. Viewing the relative intensity plot, a steady, possibly linear decrease in intensity does occur, until at 560° C, 21 % of the original intensity remain. Perhaps this specimen's direction remains mixed because the original magnetic minerals that recorded the Triassic direction have been altered or new magnetic minerals have grown and vectorially added to the original Triassic reversed direction. As mentioned, this most likely has occurred recently, as shown by the NRM present-day direction. Since only 21 % of the original remanence is remaining, apparently very little hematite is responsible for the direction seen at NRM.

From site 9 (see Figure 5) a total of fourteen specimens were collected that represented a stratigraphic section of 26.6 m of Stockton Formation red beds. The samples were measured at NRM and then thermally demagnetized at 420° C and 550° C. NRM intensities ranged from 1.3 - 16.6 (10^{-6} emu/gr). Figure 33 shows

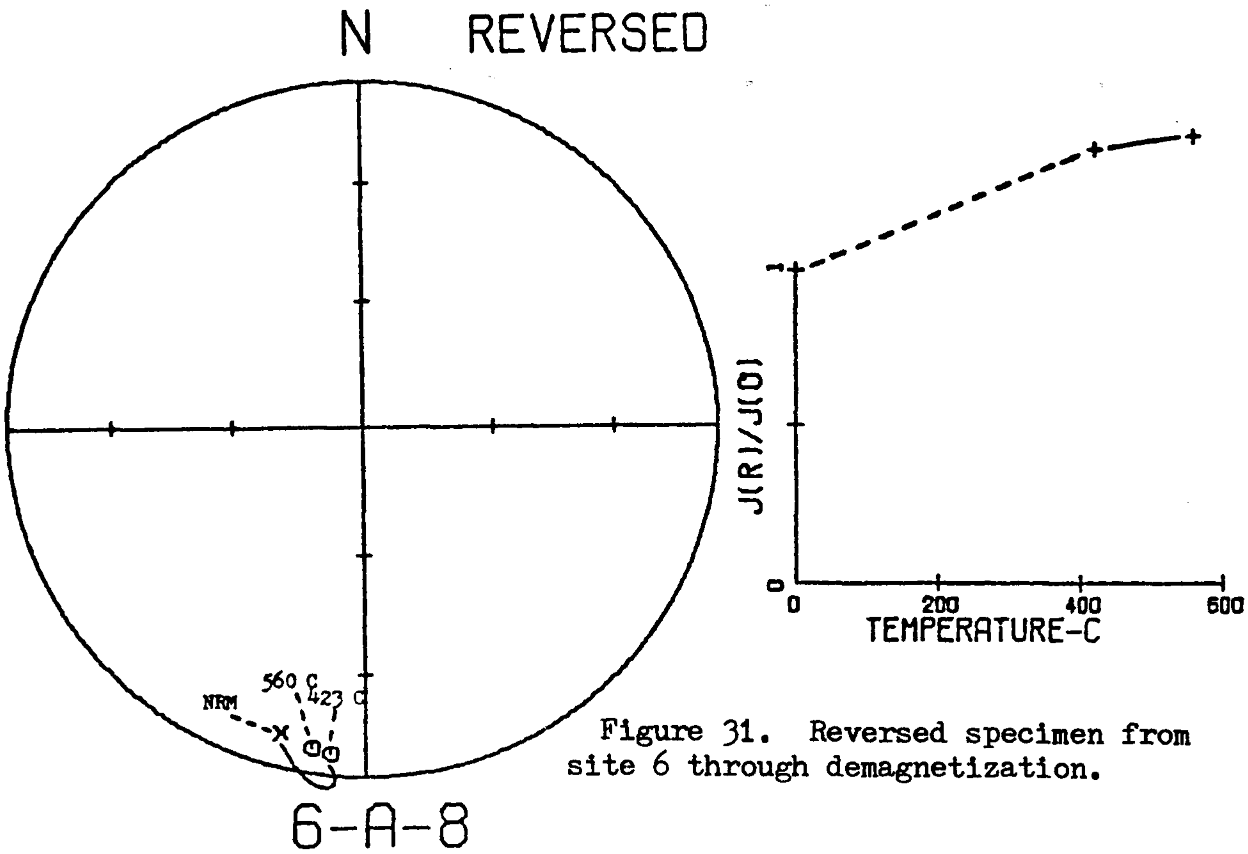


Figure 31. Reversed specimen from site 6 through demagnetization.

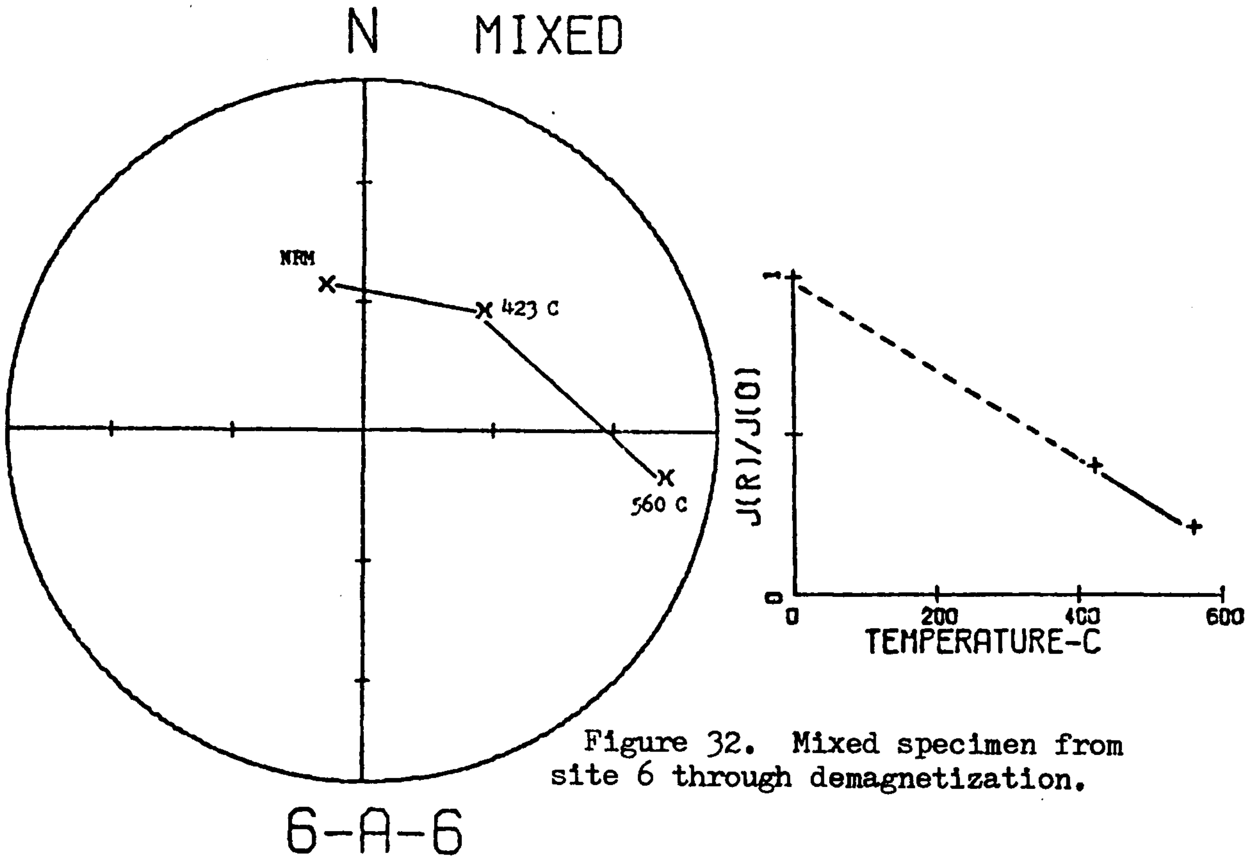


Figure 32. Mixed specimen from site 6 through demagnetization.

equal-area plots of all specimens through NRM, 420° C, and 550° C. These remain uncorrected for bedding attitudes. (Also see Appendix 4 and 5 for a compilation of sample magnetizations with demagnetization.) In addition, Figures 34, 35, and 36 are examples representing apparently normal, reversed, and mixed specimens through demagnetization, showing their directions and accompanying relative intensity plots.

Referring to Figure 33, at NRM, the directions as a whole appeared scattered. It can be noted though, there are at least five specimens that have apparently reversed declination. The remaining specimens appear smeared between Triassic normal and present-day direction. As the samples are heated to 420° C, two more specimens have moved to reversed declination, and the previously reversed specimens move progressively toward a better reversed direction. One specimen's inclination even becomes reversed. The remaining directions that appeared intermediate between Triassic normal and present-day directions remain intermediate.

Finally, at 550° C, seven specimens have reversed declinations, with two also having reversed inclination. The specimens that were originally intermediate between Triassic normal and present-day appear to have slightly scattered. It appears that at least two specimens have Triassic normal directions. Three specimens remain intermediate between Triassic normal and present-day direction, one being at present-day direction. The remaining two directions have appeared to move slightly southward and perhaps at

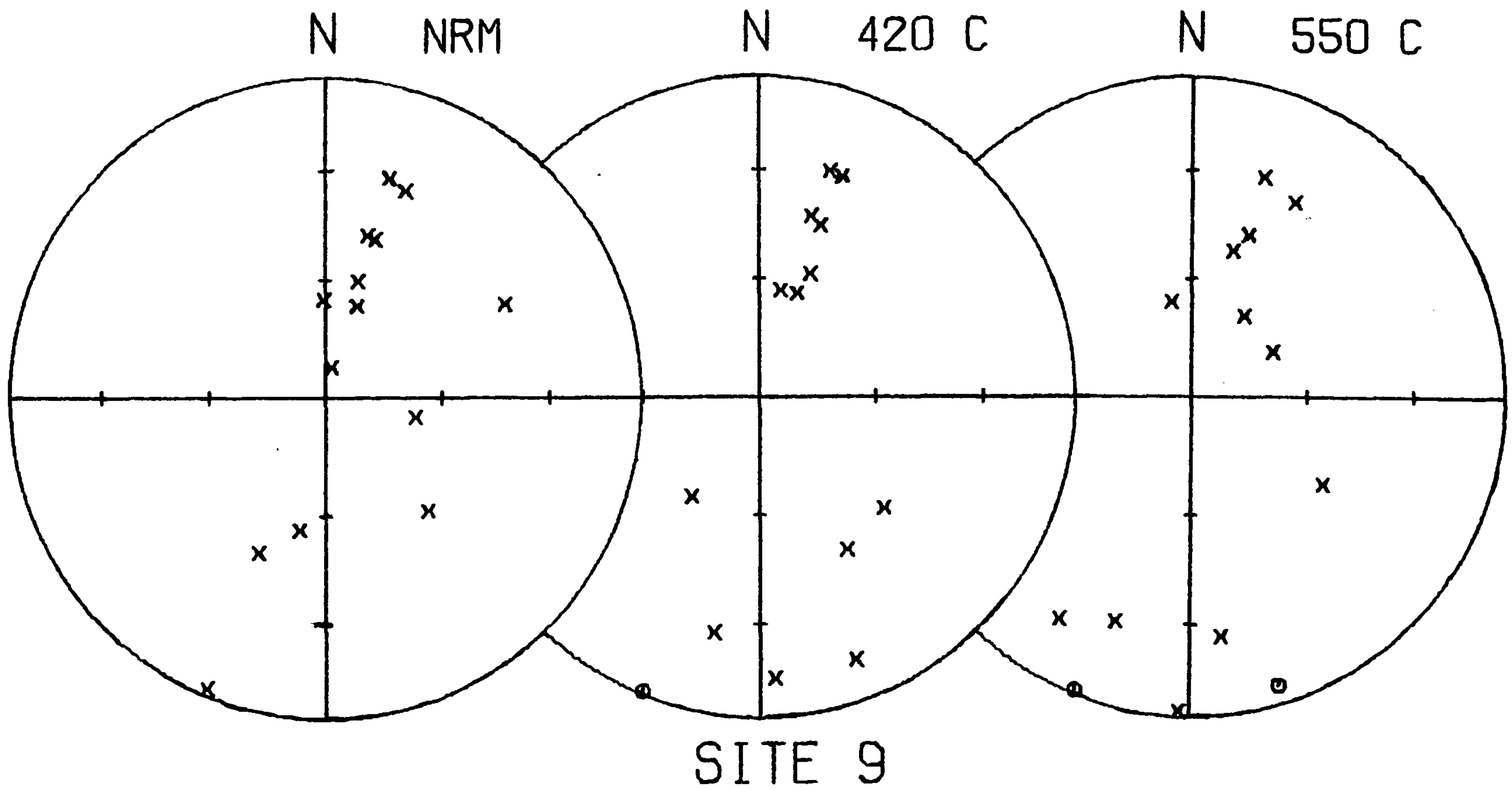


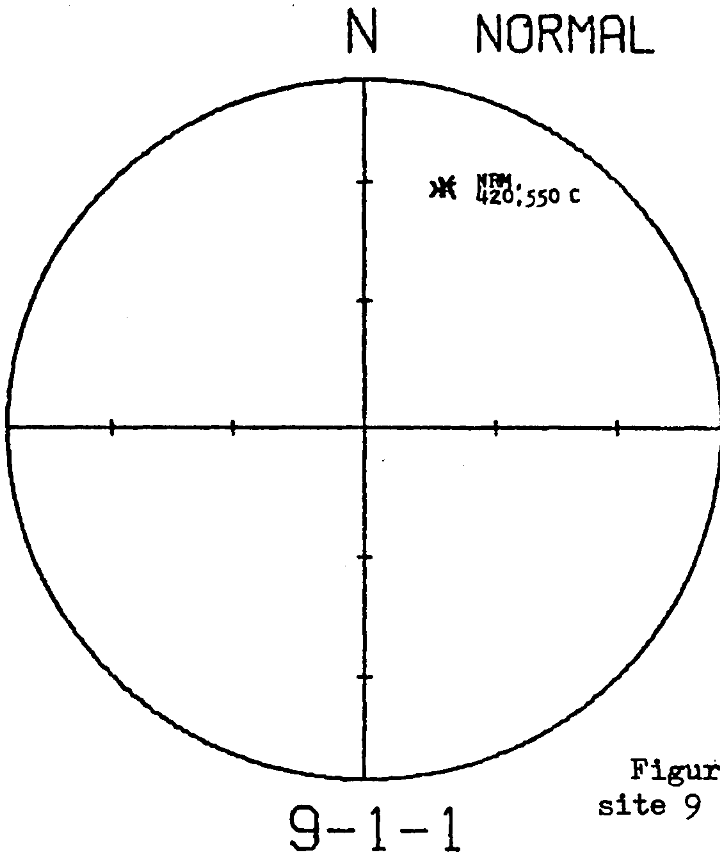
Figure 33. Site 9 red beds. Directions through demagnetization.

higher temperatures, would move to reversed declinations.

Examining Figure 34, an example of the normal specimen through demagnetization, little change in direction at NRM, 420° C, and 550° C occurs. On the accompanying intensity plot, very little decrease in intensity takes place from NRM to 420° C, but at 550° C, 52 % of the original intensity remains. Apparently hematite is principally responsible for the NRM and direction at 550° C now observed.

Figure 35 shows an example of a reversed specimen with a slight change from NRM to 420° C. Movement from a normal to reversed inclination does occur, but little change takes place thereafter at 550° C. On the accompanying relative intensity plot, it is seen that at 420° C and 550° C an increase from the initial intensity does occur. Again, a normally directed vector has been removed leaving a better Triassic reversed direction along with an increase in intensity. Hematite is most likely responsible for nearly all the remanent magnetization seen at 550° C.

Figure 36 represents a specimen that shows mixed directions (neither Triassic normal or reversed) through and at the end of the heating treatment. At NRM the direction appears near present-day direction and at progressive temperatures of 420° C and 550° C, a slight movement southward occurs. Viewing the relative intensity plot, at 420° C, 58 % of the original intensity remains and at 550° C, 38 % remains. Apparently hematite



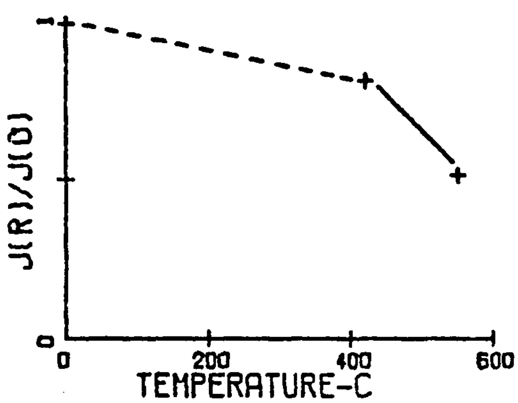
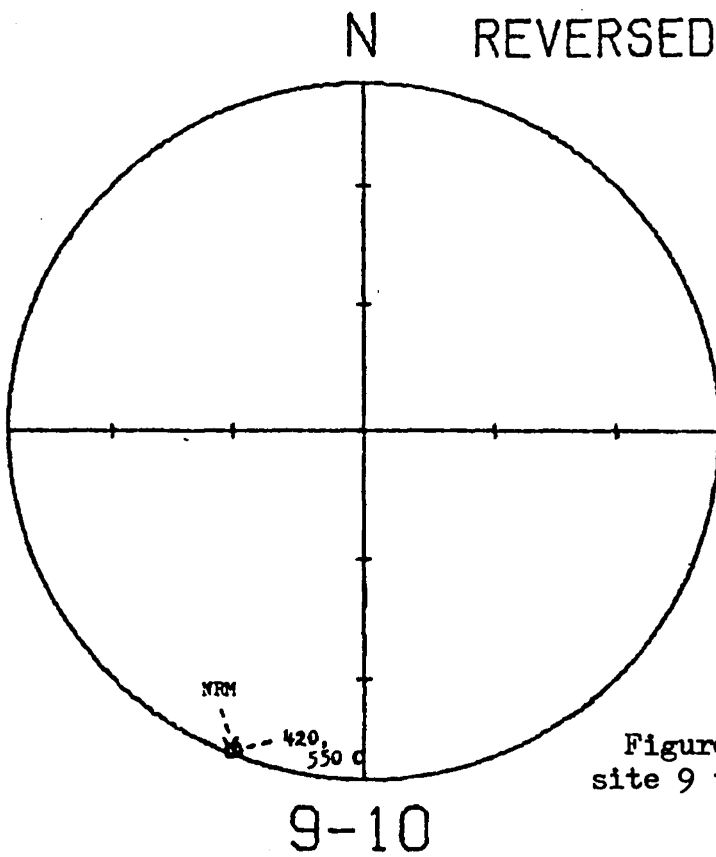


Figure 34. Normal specimen from site 9 through demagnetization.



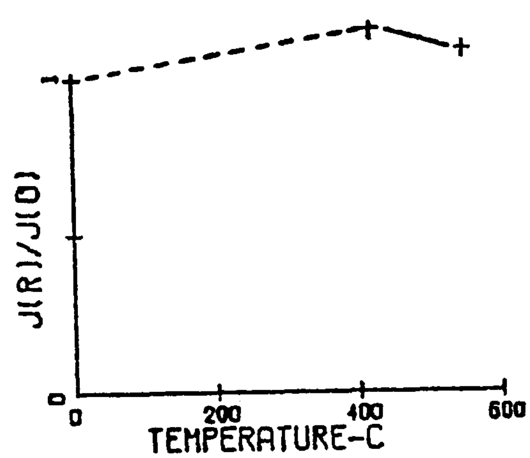
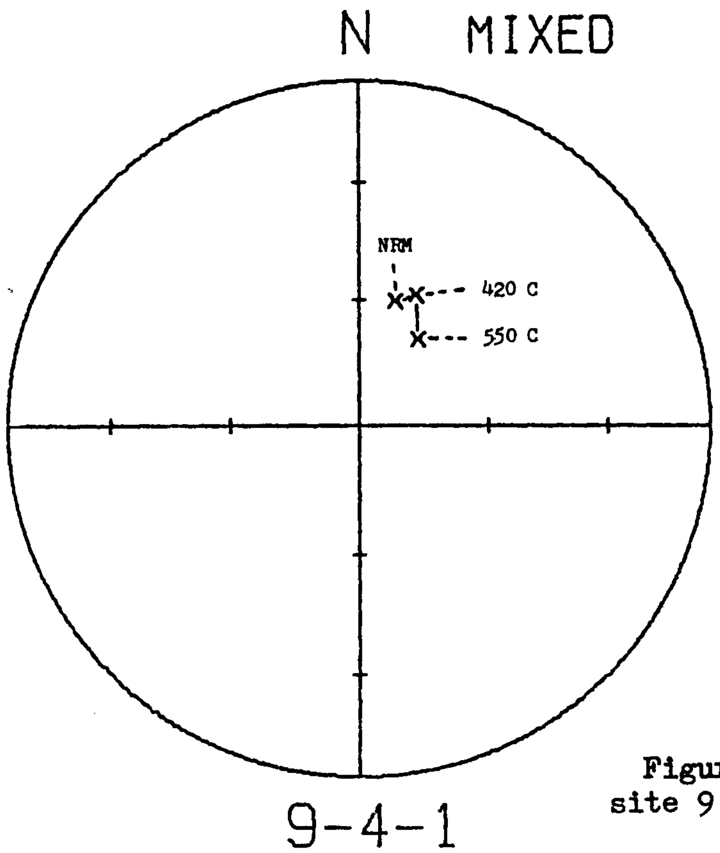


Figure 35. Reversed specimen from site 9 through demagnetization.



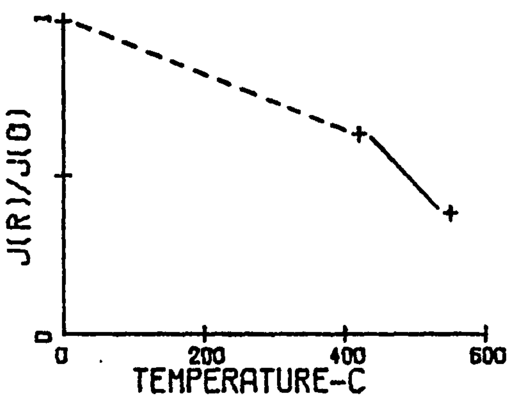


Figure 36. Mixed specimen from site 9 through demagnetization.

is responsible for much of the original direction seen at NRM and is now responsible for the present-day direction observed at 550° C. It is most likely responsible for the hard overprint that obscures a good Triassic normal or reversed direction.

Summarizing the directions at site 9, at 550° C, at least six specimens have reversed polarity, two have normal polarity, and the remainder (six) are mixed. Apparently a normal interval did exist at this site. The great number of mixed and apparently reversed directions that did not show a good Triassic reversed direction, may be due to the fact that either a hard overprint was acquired that was not removed even at 550° C, or that the field was in a transitional stage between normal and reversed polarity and was essentially non-dipolar.

Summarizing the results for sites 5, 6, and 9, all of these sites had reversely magnetized intervals of over 10 m thickness. Two of the sites, 5 and 9 had normally magnetized intervals, but they were not well-defined. An attempt to magnetically correlate these sites is presented in the discussion section of this paper.

Site 7

Additional samples were collected from the Stockton Formation at site 7 (see Figure 4). The sampling covered two exposures, the oldest containing 19 m of stratigraphic section represented by eleven samples, and the youngest, 49 m of section represented by ten samples. The two exposures were separated by an unsampled hiatus of 134 m of section that was not prone to sampling.

The samples were measured at NRM and thermally demagnetized at 555° C and 625° C. (Two were heated to 410° C to observe the change in directions.) NRM intensities ranged from 1.7 - 21.1 (10^{-6} emu/gr). The results of the heating treatments are presented in Figure 37. (Also see Appendices 6 and 7 for listings of samples through demagnetization.) In addition, specific examples of a reversely magnetized sample and a normally magnetized sample through the demagnetization are shown in Figures 38 and 39. All of the directions shown in these stereonets remain uncorrected for bedding attitudes.

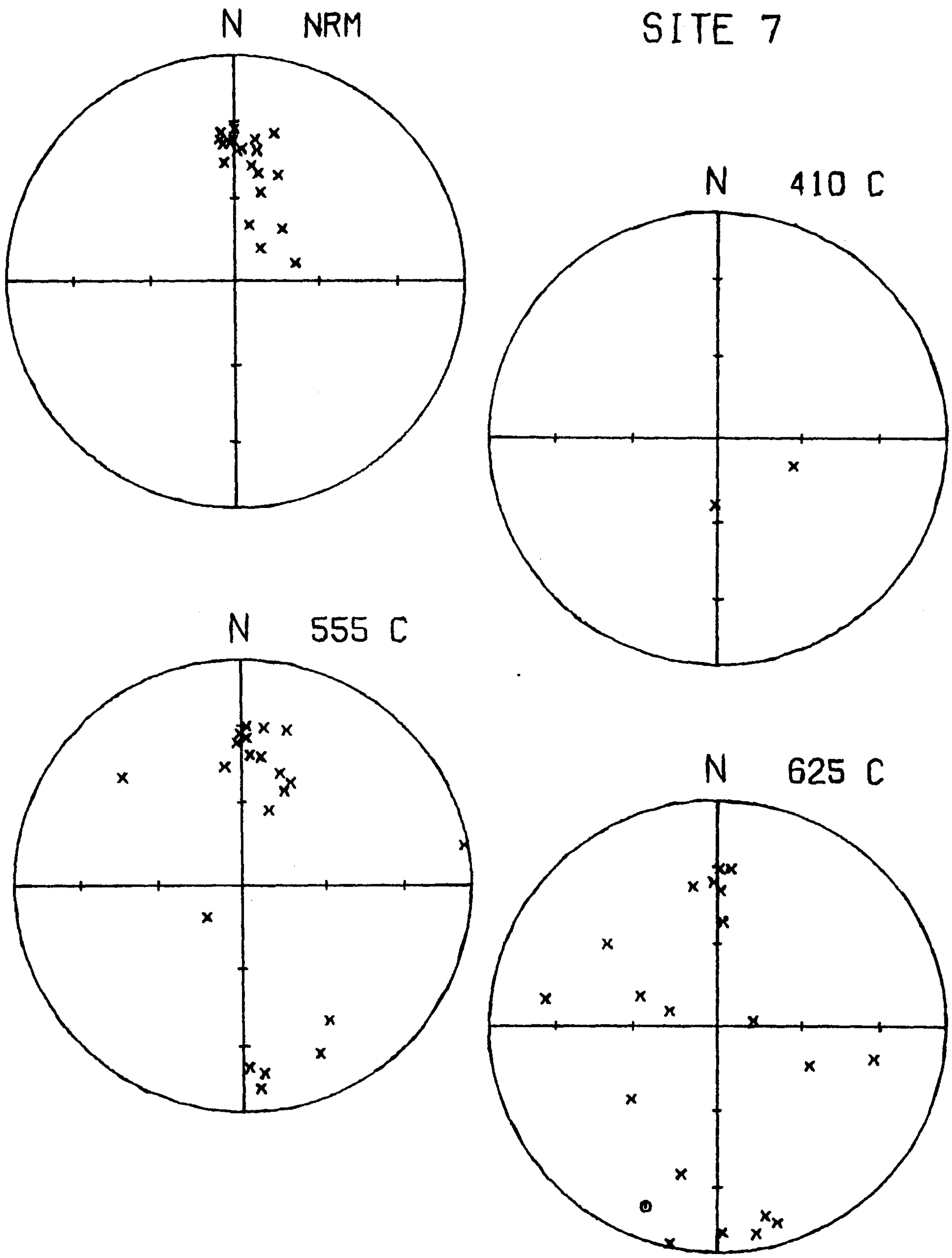


Figure 37. Site 7 red beds. Directions through demagnetization.

In Figure 37, apparent clustering occurs around Triassic normal direction before heating, but there is a streaking between Triassic normal and present-day direction. Two of the specimens that showed the greatest declinations were heated to 410° C. Their directions moved toward a reversed declination, indicating they were most likely reversely magnetized.

At 555° C, a total of six specimens had moved to a reversed declination. Two specimens appeared randomly scattered, but the remaining specimens still appear smeared between Triassic normal direction and present-day direction.

At 625° C, ten specimens now have reversed declination, with one specimen also moving to a reversed inclination. Five of the previously intermediate or random directions have moved to a more southern position, but still remain in the normal declination region. Even though these directions appear mixed, they are most likely reversely magnetized because they were sampled in a reversely magnetized interval as will be seen later. It appears that there are at least five Triassic normally magnetized samples and one sample that remains smeared between Triassic normal and present-day directions.

Figure 38 shows an example of a reversely magnetized sample through demagnetization. At NRM, the direction is very close to present-day field direction. At temperatures of 410° C, 555° C, and 625° C, the directions move progressively toward a better reversed direction, however, inclination never becomes reversed.

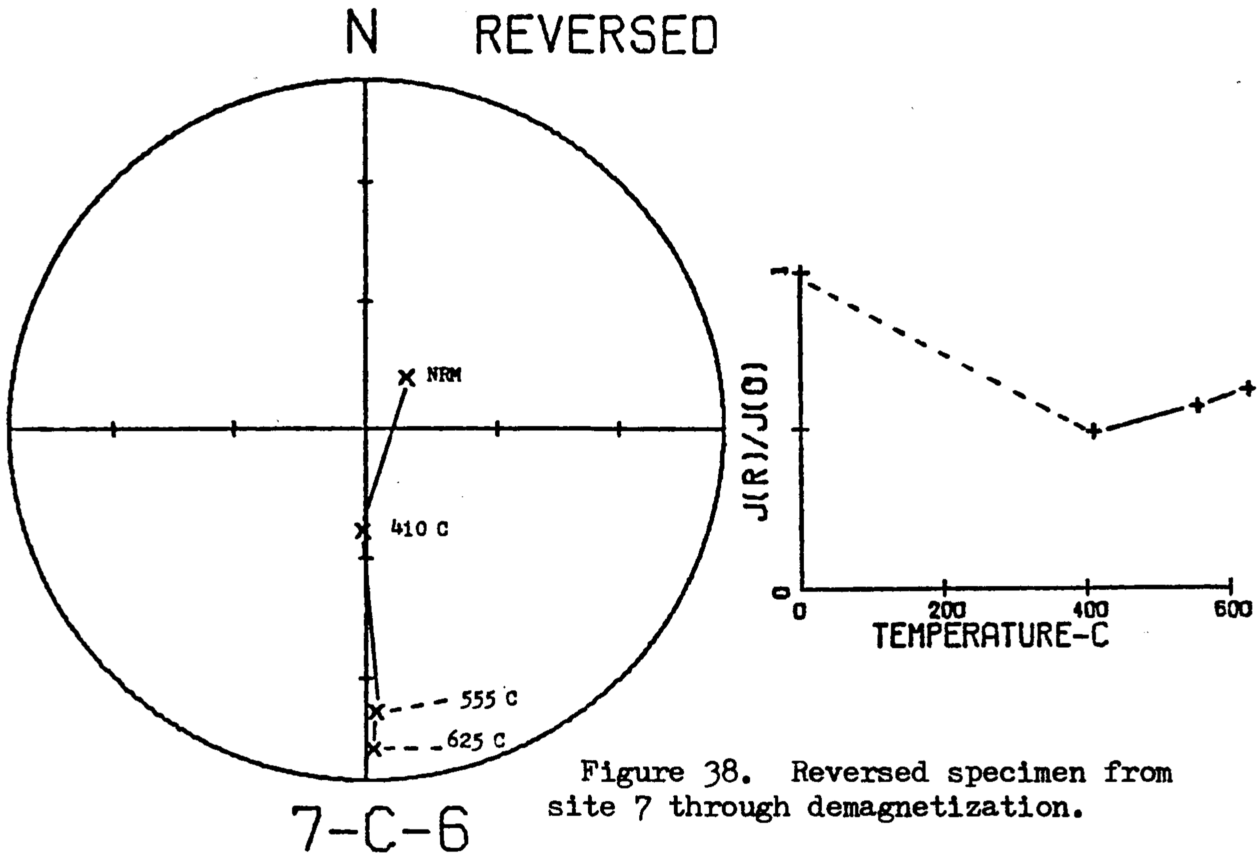


Figure 38. Reversed specimen from site 7 through demagnetization.

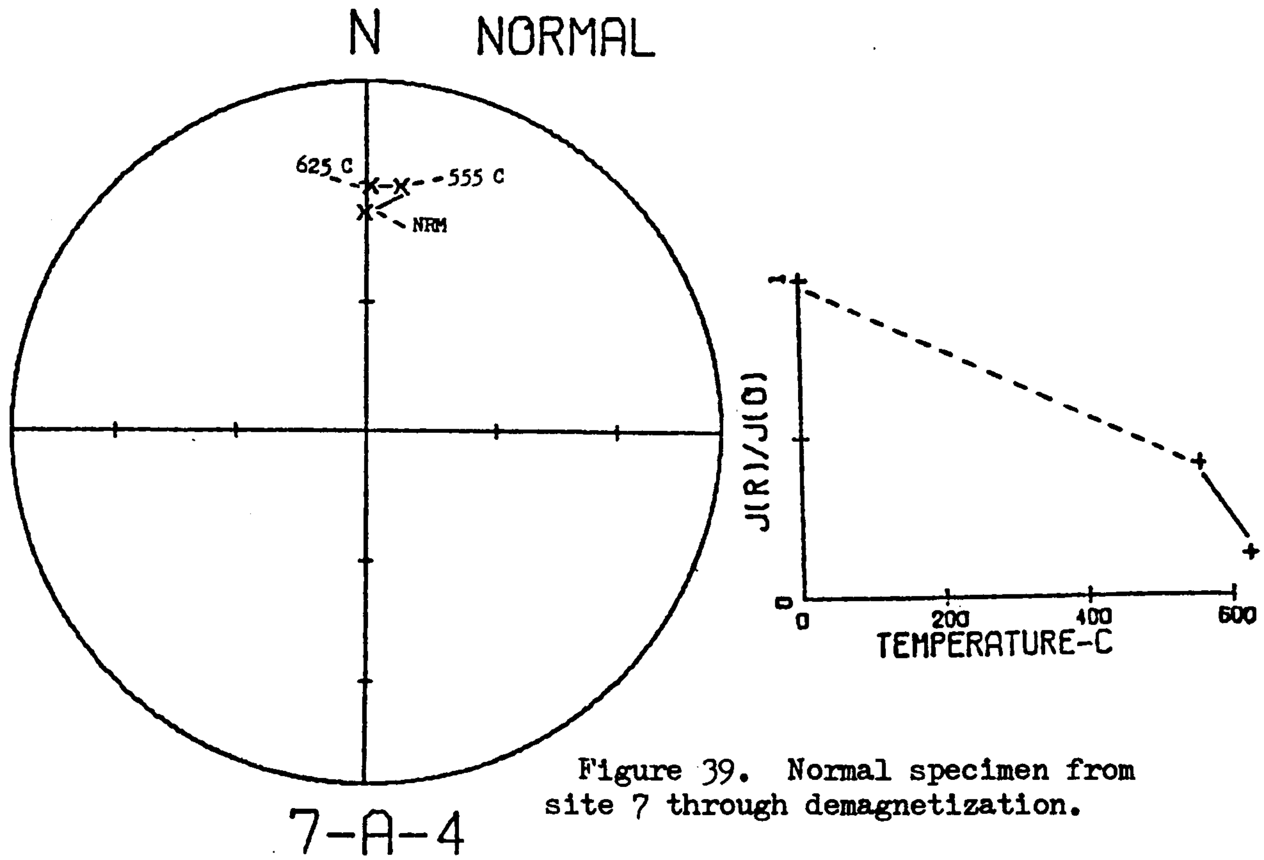


Figure 39. Normal specimen from site 7 through demagnetization.

Obviously an extremely hard overprint that is normally directed has been acquired that keeps the inclination still normal at 625° C. Viewing the accompanying relative intensity plot, a decrease in intensity occurs at 410° C, but at 555° C and 625° C an increase from 410° C does occur. Again, at least some of the magnetic minerals responsible for a normally directed vector have been removed causing an increase in intensity. Apparently a sizable amount of hematite is responsible for the original remanence of this sample.

In Figure 39, the example of the normally magnetized sample, NRM direction is near Triassic normal. With increasing temperatures of 555° C and 625° C, the direction moves slightly, but closer to the Triassic normal direction. Viewing the relative intensity plot, at 555° C, 42 % of the original intensity remains and at 625° C, 13 % of the original intensity remains. Apparently there was a sizable amount of magnetite responsible for the original remanence of the ($<$ 29 %) and not a great quantity of hematite responsible for the initial remanence measured.

Summarizing the results from this site, it appears that the oldest sampled exposure consisted of reversely magnetized or mixed (neither Triassic normal or reversed) direction specimens. The youngest 49 m section sampled consisted of a well-defined normal interval and then a reversed interval represented by reversely magnetized or mixed direction specimens. The great number of specimens whose directions still appear mixed even at 625° C is probably due to an extremely hard overprint caused by hematite. An interpretation of the magnetic stratigraphy of this site is contained in the discussion.

Site 24

A final stratigraphic sampling was done in the quartz conglomerate-sandstone facies of the Brunswick Fm, the Hammer Creek Fm, located in the narrow neck that separates the Newark and Gettysburg basins (Figure 4). A total of ten cores were retrieved that represented a stratigraphic section of 36 m.

The samples were measured at NRM and stepwise thermally demagnetized at temperatures of 423° C and 560° C. NRM intensities were low for these coarse grained lithologies and ranged from 0.52 - 5.27 (10^{-6} emu/gr). (Also see Appendices 8 and 9 for a listing of samples through demagnetization.) The resulting directions, uncorrected for bedding attitude, are presented in Figure 40.

In Figure 40, it is seen that NRM directions appear rather scattered, but loosely clustered about present-day. One specimen has a reversed declination. At 423° C, directions move only slightly. One additional specimen shows a reversed declination. Finally, at 560° C, the directions still appeared scattered. Now four cores have reversed declinations. None of the specimens showed a good Triassic normal or reversed direction. Possibly a reversed interval is indicated by the four specimens with reversed declinations.

It is believed that the reason for the poor directions and low intensities, even after 560° C cleaning, was due to the

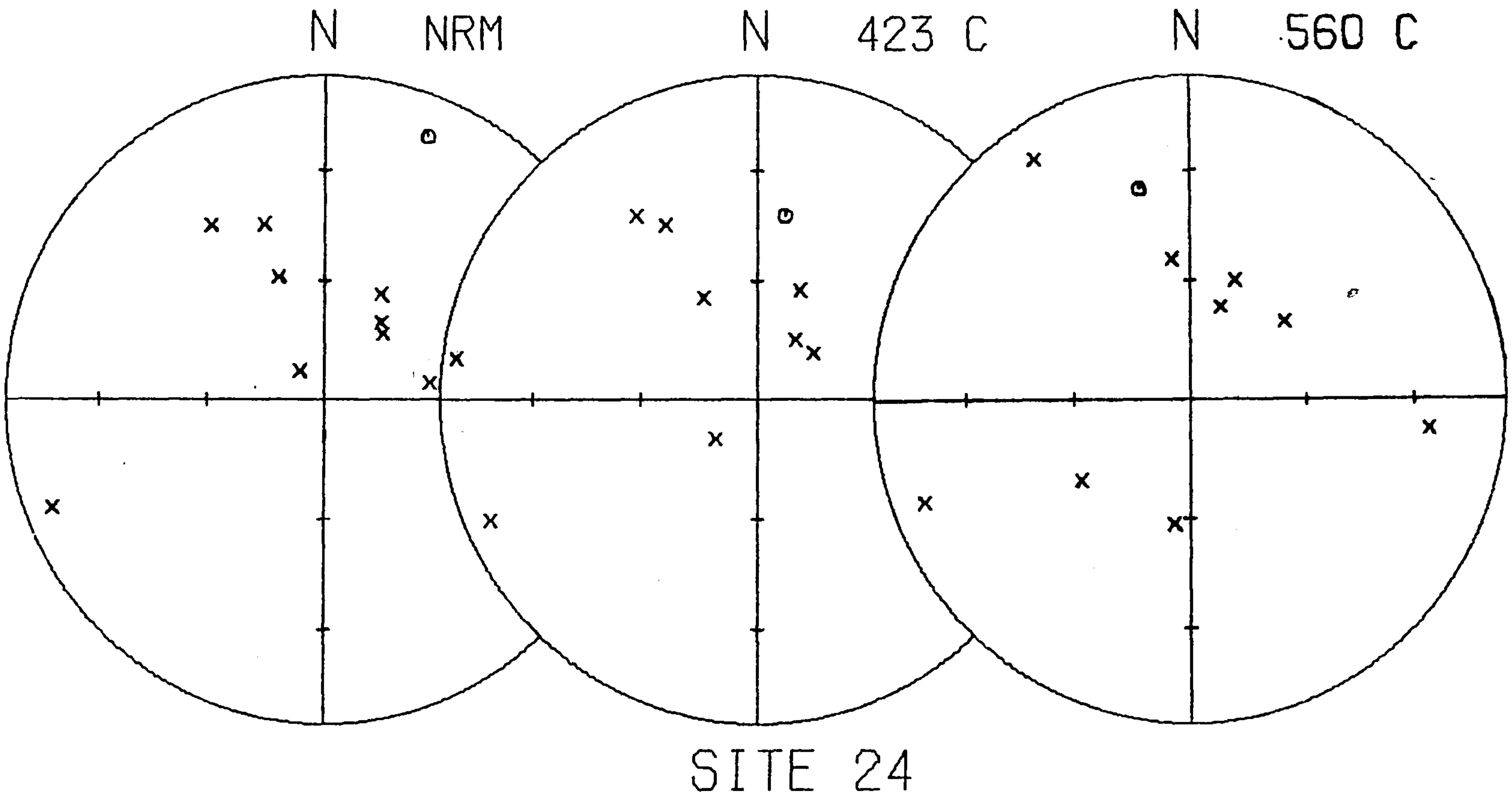


Figure 40. Site 24 red beds. Directions through demagnetization.

coarse grained lithologies. Other workers have found that sediments from high energy environments are poor paleomagnetic recorders (Cain and others, 1977). Apparently the remanence is due to hematite for, noting the relative intensities remaining at 560° C (see Appendix 9), all but one specimen had at least 38 % of J_r/J_o remaining. Perhaps these samples had acquired a hard hematite overprint that obscured good Triassic directions. Heating to 600° C may have improved these directions slightly. Because these directions are not considered acceptable by the author, no Fisher statistics will be applied nor will an interpreted polarity sequence for this 36 m section be suggested.

DISCUSSION

Chemical leaching compared to thermal demagnetization

Part I of this study compared results from two demagnetization procedures, chemical leaching of iron oxides and standard stepwise thermal treatment. These procedures were applied to all sedimentary rock-types found in the Newark-Gettysburg basin. The thermally treated red beds were well-behaved. With progressive heating, directions moved closer toward a Triassic normal or reversed direction. Apparently, thermal demagnetization is effective in isolating the primary carrier of magnetization (hematite) responsible for the Triassic direction in these red beds. Some anomalous results were seen, but were usually from non-red beds or coarse grained sandstones and conglomerates.

Chemical leaching results for the same samples were less consistent. On the basis of the leaching results, three behaviors were observed (Figure 7), requiring an explanation for the three types. The specimens used in the leaching had NRM directions near Triassic normal or reversed.

Group I specimens had directions that, with increased leaching time, moved slightly or not at all. For Group II specimens the directions either slowly migrated or quickly flipped to a position nearly antipodal with increased leaching. Many times the directions returned to nearly that at NRM, and for some specimens the change in directions was oscillatory throughout the leaching interval. The movement of the direction from NRM to nearly antipodal to it was almost always accompanied by an increase in intensity. The Group III specimens had Triassic directions which appeared to be leached out, leaving a residual present-day direction.

Why were these three groups observed and what can they tell us about the diagenetic history of the rocks and the earth's magnetic field during diagenesis? Apparently there is no relationship to sample location and the group type. In other words, the groups were not dependent upon the formations found in the basin. In some cases, two groups were observed at one site. This occurred at site 2 where Groups I and II were observed and at site 15 where Groups II and III were observed. In addition, some specimens seemed to be a combination of groups. Examples would be several specimens from site 15 that displayed Group II and III behavior.

Group I specimens appeared to have only Triassic normal or reversed directions. Perhaps these specimens acquired their magnetic minerals, primarily hematite, within one polarity interval. This occurred either as detrital hematite with secondary hematite forming soon after deposition, or only secondary hematite formed soon after deposition.

Group II appeared to have recorded both normal and reversed Triassic polarities. This may have been due to a number of causes. A first possibility is that primary hematite was deposited in one polarity interval and secondary hematite formed in a reversed polarity interval. Chemical leaching may have removed the two differently acquired hematites alternately, possibly because of different grain sizes or protection of hematite by the matrix or cement. The more abundant hematite at the time of leaching will govern the magnetization observed.

A second possibility is that secondary hematite grew in over two polarity intervals or even a polarity transition. Chemical leaching alternately revealed the two polarities.

Roy and Park (1972) performed leaching experiments on the Hopewell Group of Mississippian sandstones and found results similar to Group II. Some of their samples appeared to have two and even three polarities. They attributed this behavior to a DRM and later acquisition of two different CRMS.

Group III specimens had Triassic directions leached out, leaving residual directions close to present-day. This behavior may be due to several causes. First, perhaps detrital magnetite and secondary and/or detrital hematite occurred in these red beds. The hematite was leached out, leaving magnetite which is more susceptible to a viscous present-day component. This is unlikely since little magnetite was present in any of the samples as shown from the thermal demagnetization results. (Sample 1-3 may be the one exception.) A second possibility is that detrital and/or secondary hematite was leached out, perhaps because it had small grain size, leaving a secondary hematite that grew in under the present-day field direction.

One thing to consider is that Groups I and III, which did not appear to have recorded two Triassic polarities, may indeed have done so. Perhaps the Group II specimens were just measured at an opportune time in the leaching process to observe this dual polarity nature. If this is the case, red bed magnetic stratigraphy is dubious and much of the published work should be reevaluated.

What significance do these three groups observed have for red bed paleomagnetic studies? As mentioned, one major consequence to consider comes from Group II. If two polarities are recorded in any one sample, magnetic stratigraphy developed from such samples is undependable. If this acquisition of two polarities is a result of the occurrence of two different hematites (detrital and secondary - considering each acquired over time as a pulse), perhaps thermal demagnetization acts as a broad band filter and allows all hematite to be observed (Figure 41) with the observed magnetization coming from the dominant component directions. Chemical leaching may act analogous to a narrow band filter and allow only certain hematite types to remain. This may be due to grain size or what surrounds the hematite in the matrix or cement (for example, grains with large surface areas would be removed more readily than equidimensional grains). In any event, most assuredly this is dependent upon the mechanism of hematite acquisition - when and how it was acquired.

This model is speculative. The diagenetic history of these red beds needs better understanding, particularly the formation of magnetic minerals. It seems that if the mode of acquisition of hematite can be determined (detrital or secondary), part of the question will be answered. Further studies on the magnetic mineralogy should include: optical work, x-ray diffraction analyses, Curie balance runs, and microprobe work. The last two methods would be most informative since they would examine the shape, size, and composition of the magnetic minerals, particularly hematite. The grain size may be too small for optical work. Intergrowths of hematite with ilmenite or hematite with magnetite may give false x-ray analyses (see Van Houten, 1968). With regards to shape, one might look for euhedral, subhedral, or anhedral grains to determine whether grains are detrital or secondary. Another factor to consider is that the grain size of the hematite is very small. Detrital grains probably have diameters between 0.01 - 0.5 mm and pigment or secondary

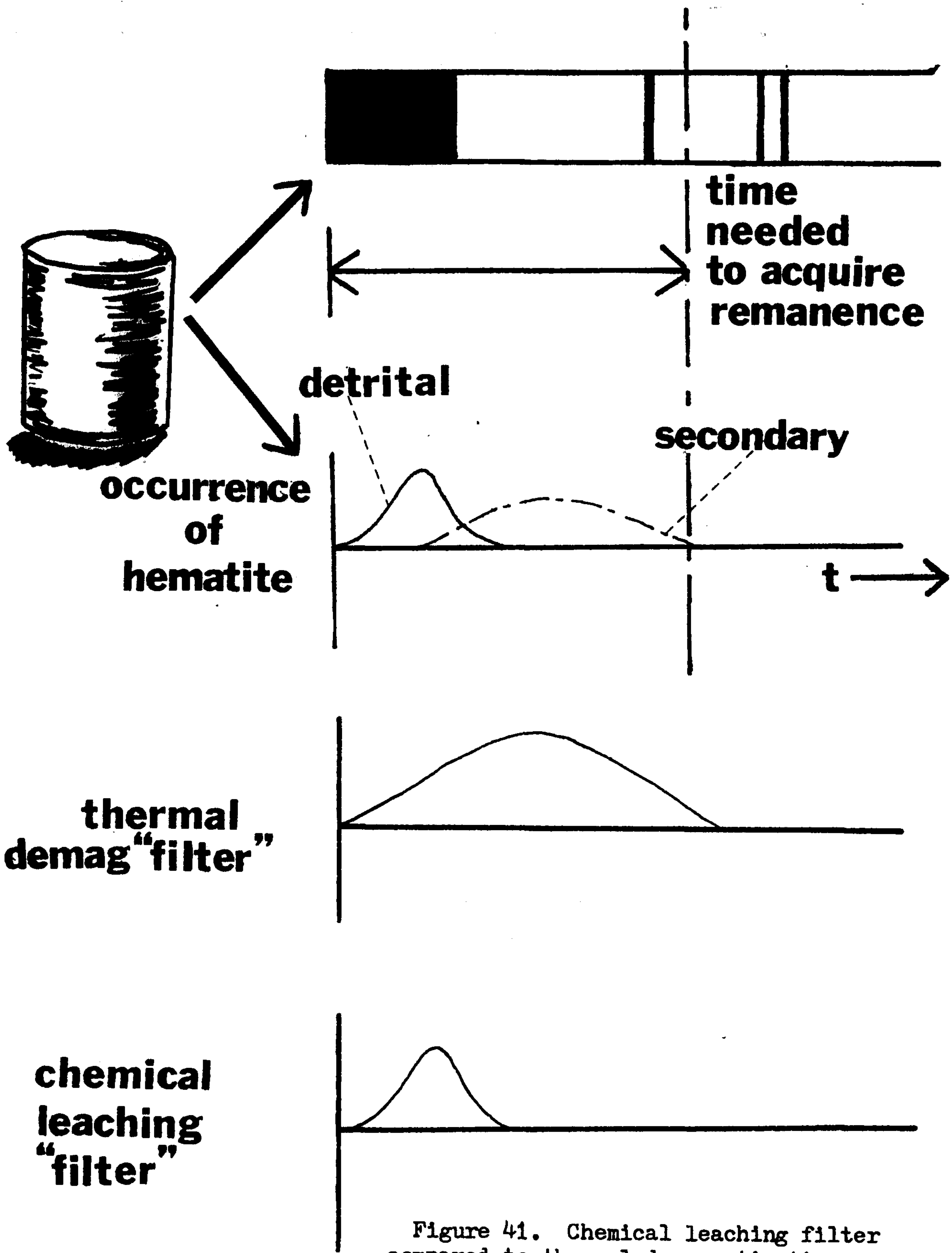


Figure 41. Chemical leaching filter compared to thermal demagnetization filter.

growths have diameters between 0.03 X 10^{-3} - 0.02 mm (see Van Houten, 1968). With respect to composition, it would be important to determine if the hematite is pure Fe_2O_3 or if it is an overgrowth of magnetite or has a magnetite core.

Some work has been done on this problem. As mentioned, Glaeser (1966) found that in the Newark-Gettysburg basin hematite was essentially secondary in the Stockton and New Oxford Formations. On the other hand, hematite was detrital in the remaining formations and members found in the basin. In addition to his work, Van Houten (1968) found in polished sections from the Brunswick and Stockton Formations that magnetic minerals consisted of essentially hematite with little or no magnetite and ilmentite. He further described a gray-brown arkose from the Stockton Fm that had abundant finely crystalline black hematite grains (specularite) with magnetite cores that often were pinpoint intergrowths of hematite and magnetite.

Summarizing, further investigation of the Newark-Gettysburg basin red beds should be done with respect to diagenesis and magnetic mineralogy to fully understand the results noted here. Chemical leaching may further be used in conjunction with thermal demagnetization treatment to determine usable and unusable sequences for paleomagnetic studies.

Stratigraphic control on demagnetization procedures

Both chemical leaching and thermal demagnetization procedures were applied to a stratigraphic control to note the similarities of intensities and directions of specimens from the same time horizon.

The control was a red bed sequence representing 33 cm of stratigraphic section from the Brunswick Fm, Rt 202, N.J. From the chemical leaching experiment of Results, Part II, this sample displayed Group II and III behavior (see Figure 7).

Nearly all the leached specimens from this sample displayed Group III behavior in which the Triassic direction appeared to be leached out, leaving a residual present-day or near present-day direction. After the 40 days of leaching, all the directions measured at this time, as well as the resulting mean, were shown in Figure 24. Table 3 listed the specimens as well as the Fisher statistics. The mean direction was 6.4°, 51.7° (N=11) with the circle of confidence, $\alpha_{95}=8.06^{\circ}$, well within the range of acceptibility. The angular deviation for this mean direction was $\sigma=13.5^{\circ}$ with the precision parameter, or measure of scatter of the directions, $\kappa=33.1$ (the larger the value of κ, the smaller the scatter of points). In addition, the calculated magnetic pole latitude and longitude was found as 80.5° N, 140.4° E (220.4° W). The oval of confidence calculated was $\delta p=7.5^{\circ}$ and $\delta m=11.0^{\circ}$. The present <u>dip</u> magnetic pole is 75° N, 101° W.

Again, why did the leaching remove the Triassic direction and leave a residual of almost present-day as observed in this Brunswick red bed sequence? As suggested before, perhaps either magnetite, more susceptible to a viscous, present-day field is responsible for the residual direction, or equally as plausible, secondary hematite has grown in recently and acquired the present-day field direction. As seen from the thermally demagnetized specimens, the specimens were well-behaved and by 600° C all samples (with the exception of three) had 40 % or more of J_r/J_o remaining. The original remanence was due primarily to hematite (or maghemite) with little magnetite as seen by the thermal demagnetization plots. Most likely then, the Triassic direction was carried by finer hematite grains that were removed first. Larger grains of hematite that had grown recently remained, but they accounted for only 10 % of J_o after 30 days of leaching.

Also observed from this control was Group II behavior or the apparent recording of two polarities. This behavior was observed in one specimen in each of the four time horizons sampled. Why did these specimens display this behavior and not the others from the same time horizon? Again, there may be several possibilities to consider. First, perhaps for some reason, the Group II specimens took longer to acquire their remanence. Equally as plausible, perhaps all the specimens had recorded dual polarities, but the time at which the measurements were made were not when the opposite component was dominant. If this latter possibility is true, as seen from this study and Results, Part I, red bed magnetic stratigraphy from this basin may not be reliable.

Estimate of time needed for red bed control to acquire remanence

It would be interesting to estimate the time needed for this control sequence to acquire remanence. It will be seen later in the discussion on magnetic stratigraphy, that a reasonable deposition rate for these red beds ranges from 0.1 - 3 m/10^3 yr. If the sequence sampled is 33 cm of section, this represents a range of 110 - 3300 yr of deposition. Considering the results from the chemical leaching, both normal and reversed polarities were recorded in at least one specimen from every time horizon. To estimate the range of time involved, consider these two possibilities. For a lower range limit, perhaps remanence was acquired during a transition from normal to reversed polarity, probably lasting 5 X 10^3 yr (Strangway, 1970). For the upper range of time, perhaps remanence was acquired over a normal and reversed event or epoch, lasting from 10^4, 10^5, or 10^6 yr (Strangway, 1970), giving an upper range of 2 X 10^6 yr. The range of time needed for this 110 - 3300 yr deposition to acquire remanence as indicated by the polarities recorded is then 5 X 10^3 - 2 X 10^6 yr (see Figure 42).

Fisher statistics of thermally demagnetized samples

The thermally treated specimens from the control were well-behaved and by 600° C, all directions had moved to a better Triassic normal direction. Figure 25 and Table 4 showed the 600° C directions, resulting mean, and Fisher statistics from the measurements. The mean was 1.0°, 26.9° (N=16). Beck (1965) found a mean of 359.5°, 23° for Pennsylvania diabase. The circle of confidence for these 600° C measurements was α_{95}=8.4°, well within the range of acceptibility. The angular deviation for the mean was σ=17.5° with the precision parameter, K =20.3 The calculated

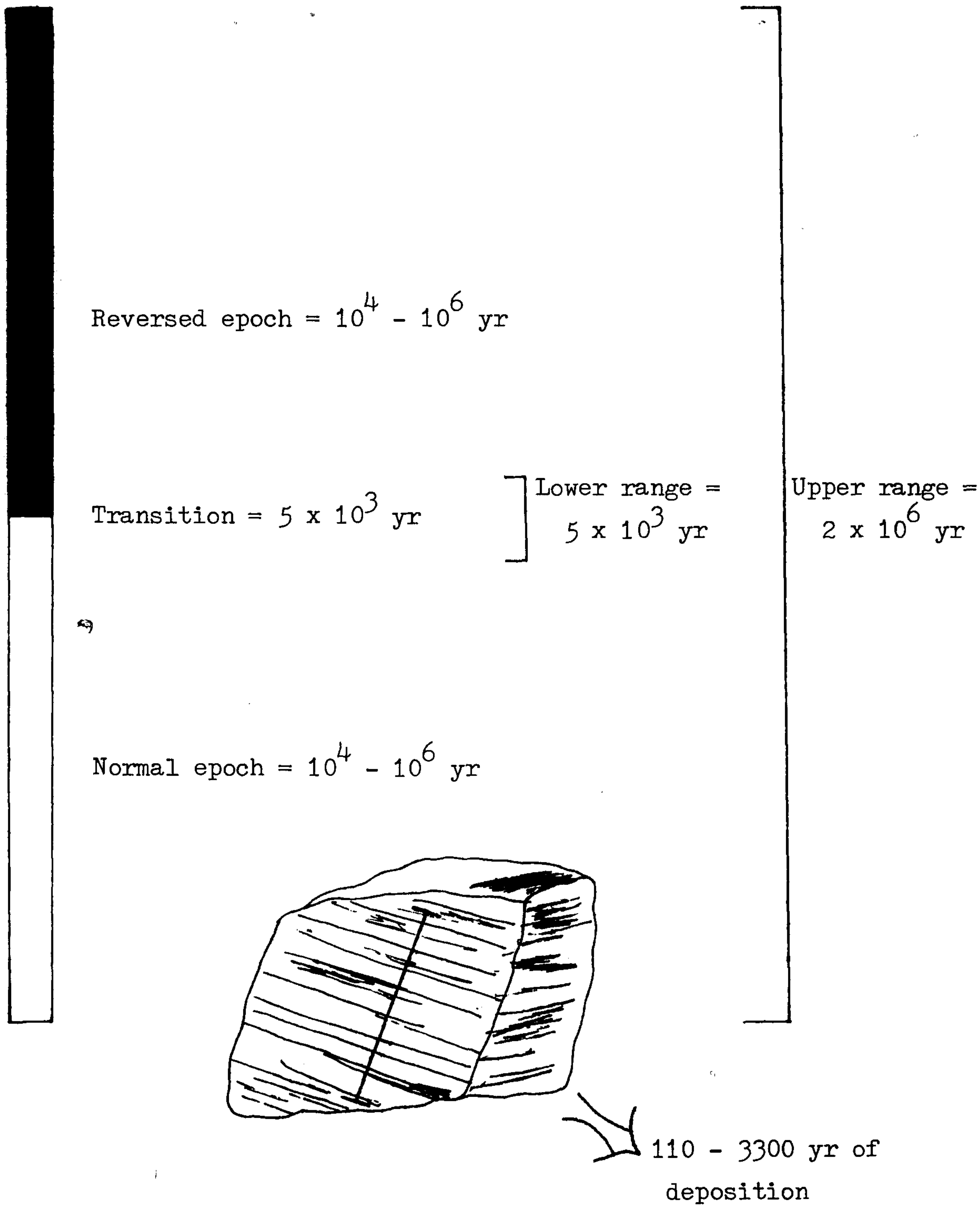


Figure 42. Range of time needed for stratigraphic control to acquire remanence, $5 \times 10^3 - 2 \times 10^6$ yr.

pole position had coordinates 63.8° N, 107.3° E (252.7° W). The oval of confidence for this pole had $\sigma_p=5.0^{\circ}$, $\sigma_m=9.1^{\circ}$. This pole position agrees well with that found by other workers. Reeve and Helsley (1972), from a combination of many workers, found the Upper Triassic pole as 62.5° N, 89° E. Beck (1965) for Pennsylvania diabase found 62.5° N, 105° E, and Opdyke (1961) for igneous and sedimentary units in the Newark Group, found 63° N, 108° E. These positions are all plotted in Figure 44. It can be said that for these site 15 samples, thermal treatment at 600° C resulted in well-cleaned directions. In addition, all the samples were rather uniform and little deviant behavior was observed.

Summarizing the control on magnetic stratigraphy for the chemical leaching, both Group II and III behaviors were observed. The specimens seemed to behave rather uniformly with respect to intensity and direction during the leaching with the exception that some exhibited Group II behavior, whereas others from the same time horizon did not. For the thermally treated specimens again, behavior was rather uniform among the four sampled time horizons, and the 600° C treatment resulted in a mean direction that yielded a Triassic pole position well in agreement with other workers (63.8° N, 107.3° E).

Magnetic stratigraphy

Sites 5, 6, and 9

As noted, site 5 was the largest sampling interval undertaken for this study. It consisted of 75 m of stratigraphic section in the Brunswick Fm red beds that graded into the Lockatong Fm and included blue-gray argillites and buff-colored, fine-grained sandstones. In conjunction, sites 6 and 9 were also sampled along strike within 5 km to the southwest of site 5. Stratigraphic samples taken from these sites were thermally demagnetized only.

At site 5, nearly all red bed specimens were reversely magnetized (Figure 26), and remanence was due primarily to hematite as seen by the thermal demagnetization behavior (Figure 27 and Appendix 5). The non-red beds sampled showed present-day or anomalous directions (Figure 28). The anomalous directions seen may have been due to the fact that the Triassic field direction was never accurately recorded or the Triassic direction was obscured by later magnetic components acquired. Very little hematite occurred in these non-red beds as seen by the thermal demagnetization plots (Figure 29 and Appendix 5).

Fisher statistics

Many samples from sites 6 and 9 (Figures 30 and 33) were also reversely magnetized. A normal interval was also recorded at site 9. Quite a few of the samples from these sites, however, showed mixed direction at the final 550° C treatment and had probably acquired a hard overprint. Many specimens from site 5 appeared well-cleaned. Because of this, specimens only from site 5 were used for the Fisher statistics. Those used were all reversely magnetized with negative inclinations and declinations within the range 135° - 225°. Figure 43 and Table 5 show these sample directions used from

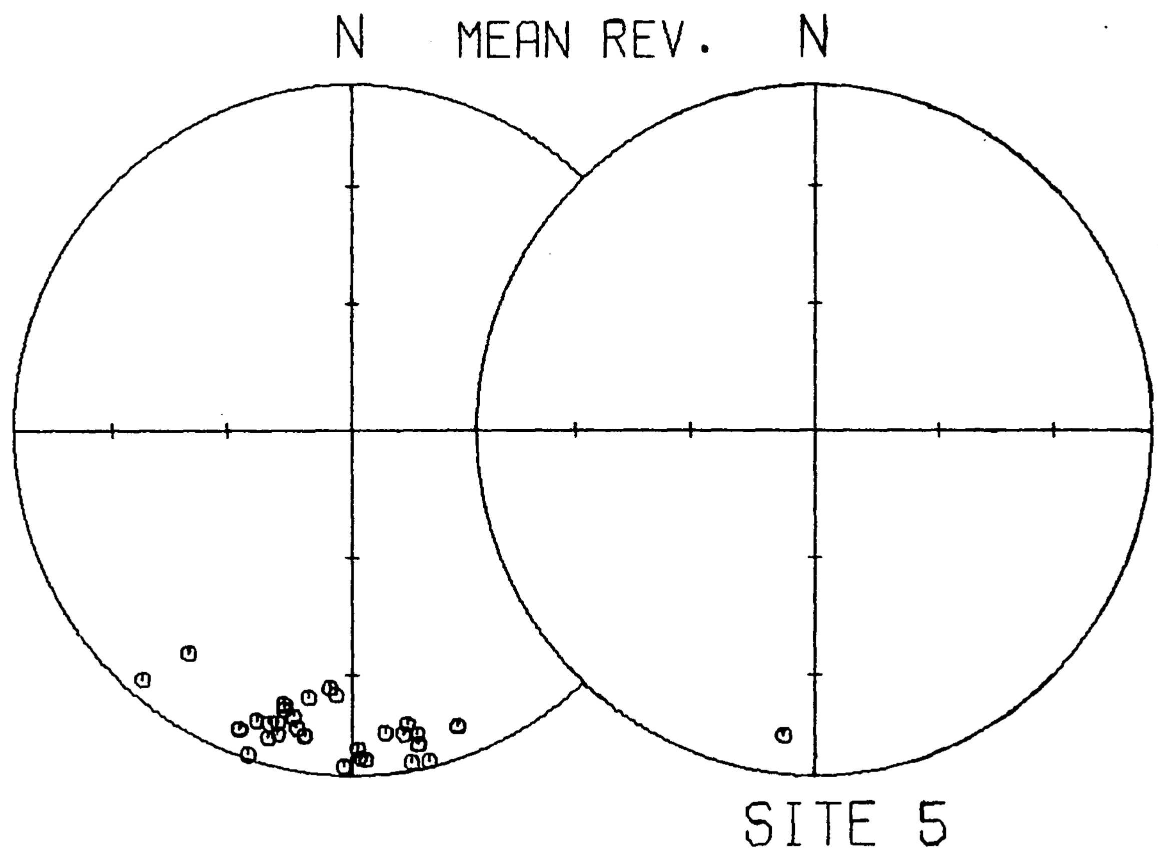


Figure 43. Selected site 5 red bed directions and mean direction at 550° C - 610° C (N=29).

TABLE 5. FISHER STATISTICS OF SELECTED SPECIMENS FROM SITE 5, 550° C OR 610° C (N=29)

FISHER ON SAMPLE DIRECTIONS

POLE ON SITE MEAN

SAMPLE NUMBER	DECLINATION	INCLINATION
5-E-2-1	167.80	-7.80
5-D-10-1	216.79	-20.53
5-D-3-1	189.50	-22.60
5-D-4-1	185.00	-26.10
5-C-8-2	167.58	-10.93
5-C-8-1	170.12	-11.83
5-C-7-1	198.20	-1.56
5-C-6-1	201.16	-8.32
5-C-2-1	196.04	-12.85
5-C-1-1	198.56	-12.53
5-B-10-1	173.60	-13.00
5-B-9P-1	194.00	-10.40
5-B-9-1	195.60	-8.60
5-B-8-1	178.60	-6.00
5-B-5-1	220.70	-5.80
5-B-4-1	177.60	-5.10
5-B-3-1	169.20	-14.40
5-B-2-1	166.60	-1.90
5-A-9-1	194.20	-19.40
5-A-8-1	183.70	-24.30
5-A-2-1	179.00	-8.40
5-AA-9-1	190.70	-13.70
5-AA-7-1	193.90	-17.80
5-AA-5-1	169.60	-2.60
5-AA-6-1	194.60	-13.60
5-AA-4-1	191.70	-16.50
5-AA-2-1	181.40	-3.00
5-AA-1-1	160.00	-9.70
5-AAA-9-1	189.10	-11.30

R=27.93636 Mean declination=185.89° Mean inclination=-12.11°

α_{95}=5.31° σ=15.57° K=26.32

Pole latitude=55.51° N Pole longitude=115.1° E σ_p=2.75°

Site latitude=40.21° N Site longitude=75.28° W σ_m=-5.40°

site 5 (N=29), along with the resulting mean and the Fisher statistics. The calculated mean reversed direction was 185.9°, -12.1°, a bit shallow of being antipodal to Beck's (1965) Triassic normal mean for Pennsylvania diabase (359.5°, +23°). Apparently a hard overprint has been acquired by all red bed samples at sites 5, 6, and 9.

The circle of confidence for the mean calculated at site 5 was α_{95}=5.3°, again most acceptable for reliability. The angular deviation of the mean direction was δ=15.6° with the precision parameter, K=26.3. The calculated pole position was 55.5° N,

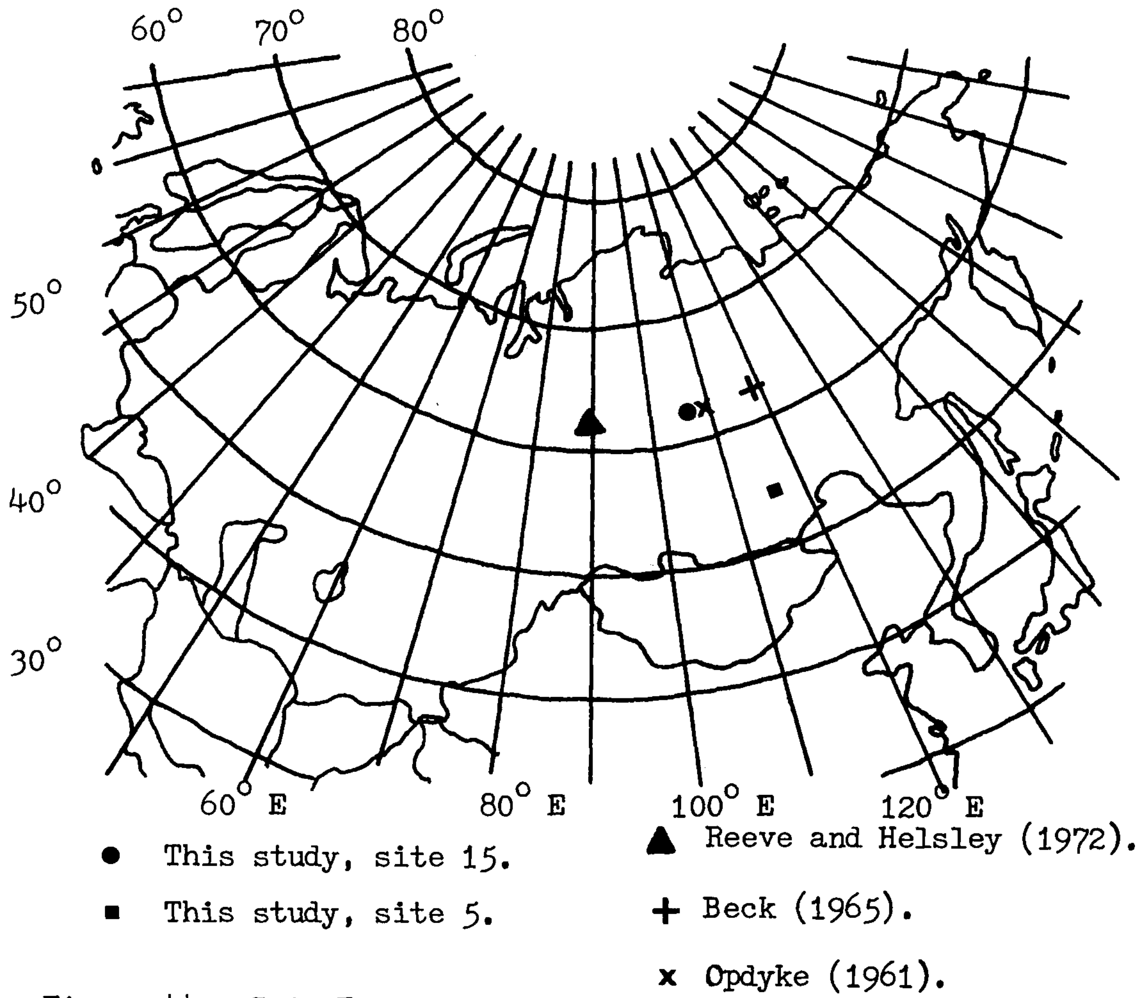


Figure 44. Late Triassic pole positions for North America determined from this study and others.

115.1° E (244.9° W), with an oval of confidence, $\sigma p=2.8°$, $\sigma m=-5.4°$. In summarizing Upper Triassic poles from North America, Reeve and Helsley (1972) found a mean position of 62.5° N, 89° E combining North American results, Beck (1965) found 62.5° N, 105° E for Pennsylvania diabase, and Opdyke (1961) for the Newark Group found 63° N, 108° E. These poles, along with the pole calculated for site 5, are plotted in Figure 44. This pole calculated from site 5 is in agreement with these other workers. The latitude appears slightly low, but this is due to the shallow inclination recorded by these reversely magnetized samples caused by a hard overprint (possibly present-day) not removed by the thermal treatment.

Correlation of sites and duration of reversed interval

As mentioned, the reversely magnetized interval found at site 5 also extended to site 6 and 9. It is necessary to point out that site 9, although located within 5 km of sites 5 and 6, is mapped in the northern extent of the Stockton Fm. The other two sites are included in the Brunswick Fm. An assumption has been made that the reversely magnetized interval at sites 5 and 6 is the same as that at site 9. However, there are three possibilities.

As a first consideration, even though sites 5 and 6 and site 9 are mapped as two different formations, they represent a facies change that is time equivalent - or at least magnetically time equivalent. A second possibility is that site 9 has been mistakenly mapped as the Stockton Fm. Finally, also a consideration is that the reversely magnetized interval recorded at site 9 is not the same as that recorded at sites 5 and 6. Again, because of the close proximity of these sites along with the fact they are along strike, sites 5, 6, and 9 are assumed to have recorded the same reversal interval.

Another interesting point to mention, as noted, site 9 is located at the northern extent of the Stockton Fm. Site 7, which will be discussed shortly, is contained within the fault block that raised the lower portion of the basin. Essentially, what is seen is a repeat of the stratigraphic sequence contained in the lower section of the basin. Therefore, site 7 also at the northern extent in the Stockton Fm, may be stratigraphically equivalent to site 9. Reversely magnetized intervals were also reported at site 7 in this study. These may be equivalent to the interval reported at site 9, and even sites 5 and 6.

A speculation on the correlation of the magnetic stratigraphy of these three sites 5, 6, and 9 is shown in Figure 45a. (Also see Figures 45b and c.) With additional work, it may be possible to correlate this reversal interval with other North American Triassic units and even with worldwide units. It is also of interest to speculate on the time duration of the field reversal recorded in the interval measured, even though the lower and upper limits were not determined at site 5.

There are several ways to estimate the time represented by the reversely magnetized interval at site 5. From Figure 45a, it is seen that 65 m of section was interpreted as

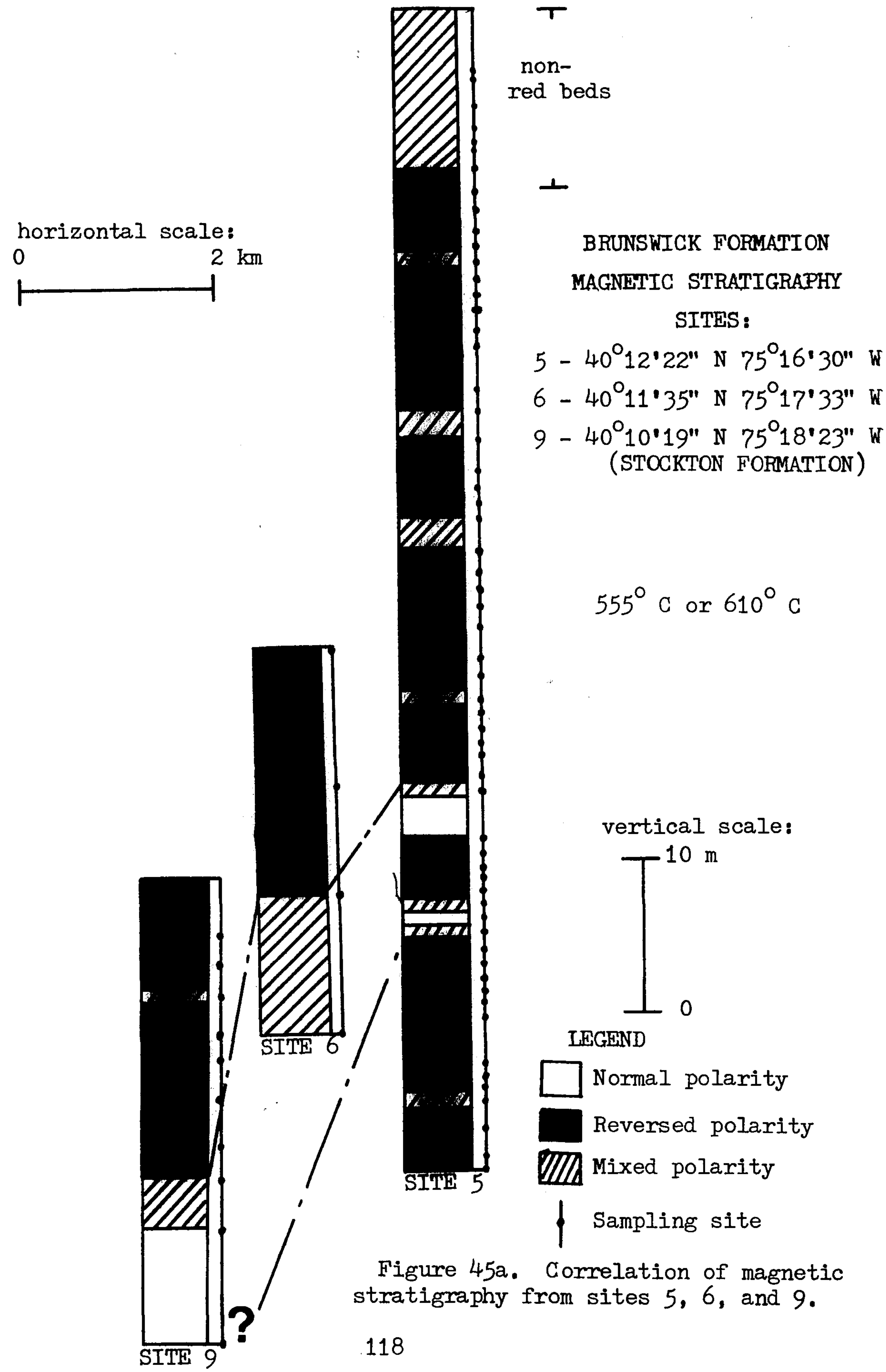


Figure 45a. Correlation of magnetic stratigraphy from sites 5, 6, and 9.

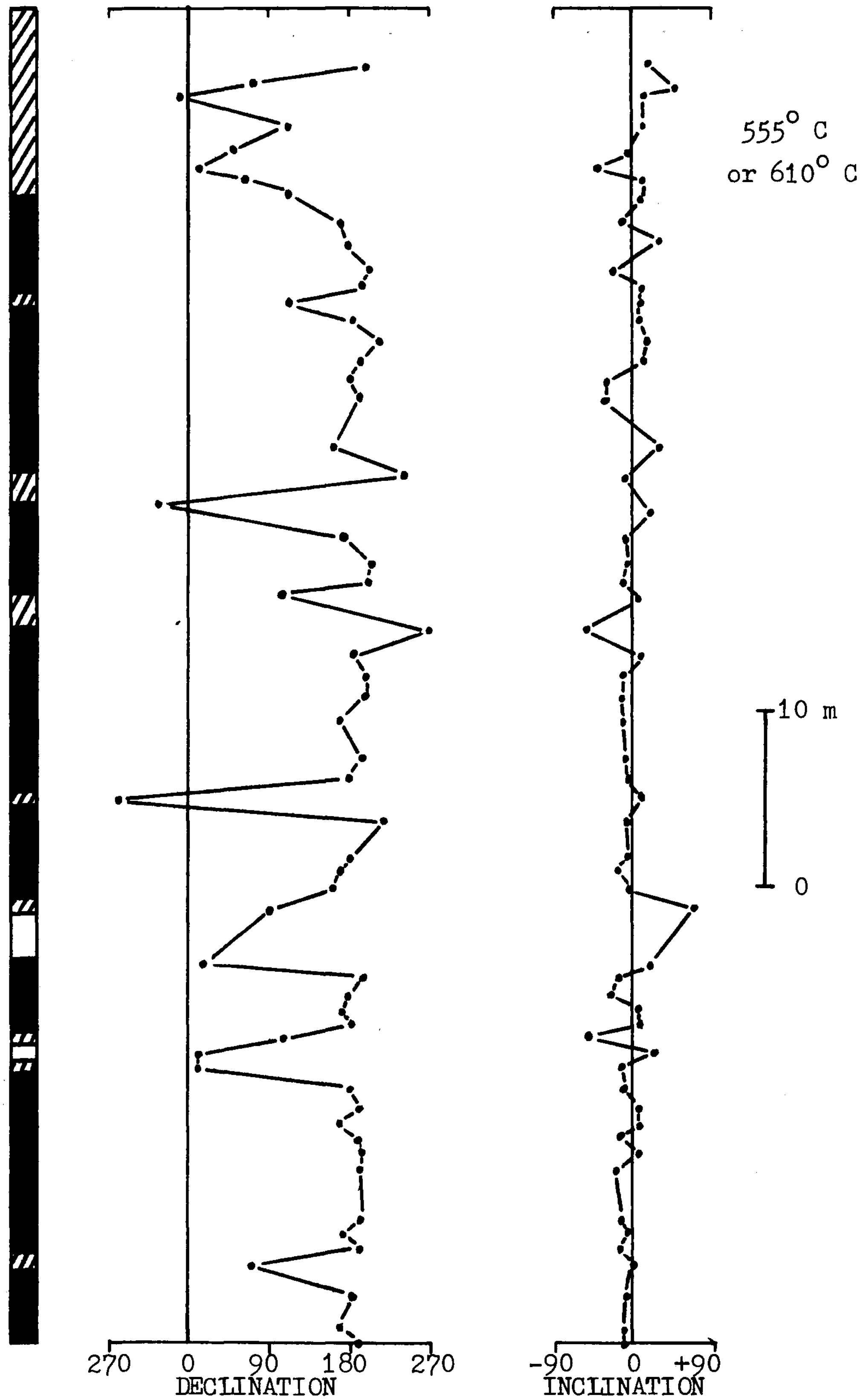


Figure 45b. Magnetic stratigraphy from site 5 (legend same as in Fig. 45a).

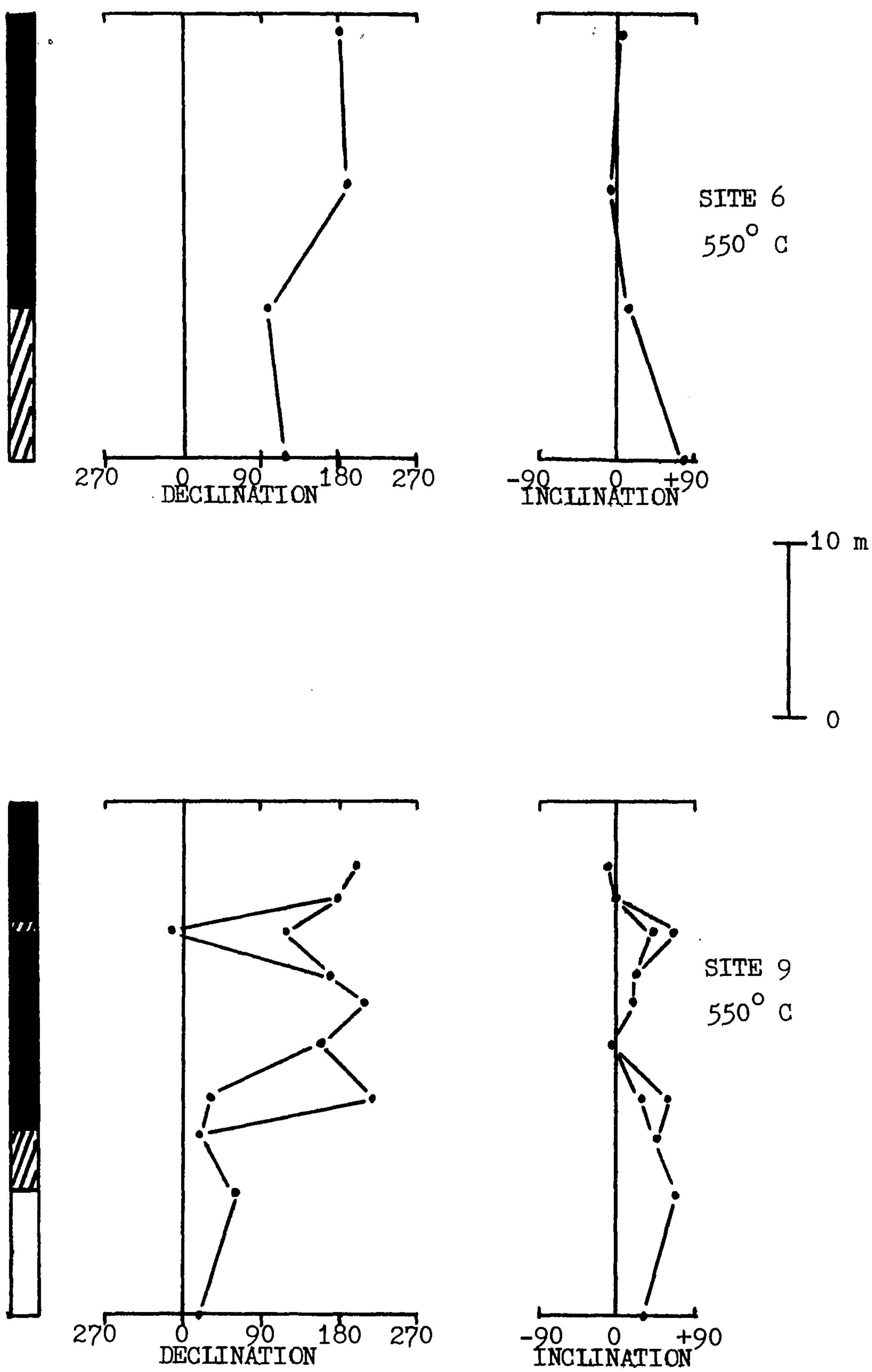


Figure 45c. Magnetic stratigraphy from sites 6 and 9 (legend same as in Fig. 45a).

reversed. (For simplicity, the two short, less than 3 m of normal section will included in the total section.) If at least 65 m of section is reversed, what is the lower range of time that the earth's field was reversed? Of course, we must assume that these red beds acquired remanence during or shortly after deposition, which may not be the case.

To determine the time of accumulation represented by the section, one needs to know their depositional rate. Khramov (1967) found for littoral, deltaic, and fluvial sediments that the rate was 0.3 - 3 $m/10^3$ yr and Fisher (1969) found for terrigenous sediments, a depositional rate of 0.1 - 3 $m/10^3$ yr. Another method would be to divide the total thickness of the sediments in the basin by the time needed to deposit them. If the thickness of sediments in the Newark basin ranges from 15,800 - 29,200 ft or 4816 - 8900 m (Glaeser, 1966), and the duration of Upper Triassic is about 15 m.y., one calculates the rate of deposition for these red beds as 0.6 - 3 $m/10^3$ yr. This is surprisingly close to Khramov's values.

Using a range in the depositional rate of 0.1 - 3 $m/10^3$ yr, the 65 m section indicates that this Triassic reversal event lasted between 21,700 - 650,000 yr. Again, most likely, the interval lasted longer, but the lower and upper limits of the reversal interval were not determined from site 5. The lower limit was not exposed, while the upper limit was hindered by a non-red bed sequence. It is interesting to note the chemically leached specimens from this site displayed Group III behavior.

Site 7

Site 7, sampled in the Stockton Fm along the Delaware River, also revealed a reversely magnetized interval. Figure 46a shows the interpretation of magnetic stratigraphy from this site. (Also see Figure 46b.) The exposure was interrupted by an unsampled hiatus of 134 m, but the section sampled represented more than 67 m of section. Apparently two separate reversal intervals were recorded. The youngest interval ended with mixed direction specimens. A hard overprint due to hematite had been acquired at this site, for at 625° C, the directions were still not suitable to apply Fisher statistics. As mentioned, there is a possibility that this Stockton Fm reversal interval correlates with the site 9 Stockton Fm reversal interval. It is informative to point out the chemically leached sample from this site exhibited Group II behavior, or the recording of two polarities.

Site 24

Unsatisfactory directions were obtained at the sampling done at site 24, a quartz conglomerate-sandstone facies of the Brunswick Fm, the Hammer Creek Fm found at the narrow neck separating the Newark and Gettysburg basins. Intensities were low and directions were poor at NRM. With increased heatings to 550° C, the directions seemingly did not improve. Apparently, this coarser grained sandstone had not accurately recorded the Triassic paleofield or, secondary components acquired had obscured it, even after heating to 550° C. The remanence, however, still seemed to be

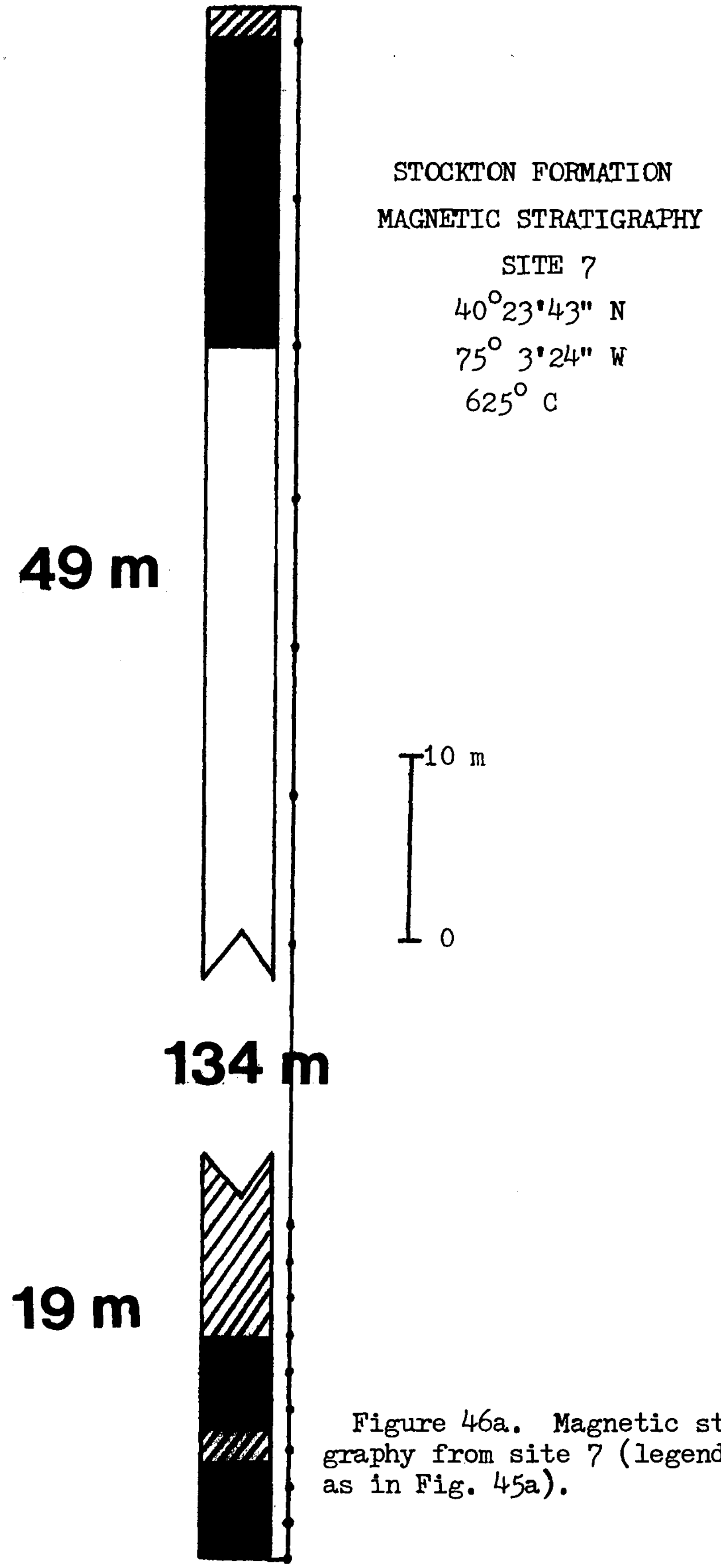


Figure 46a. Magnetic stratigraphy from site 7 (legend same as in Fig. 45a).

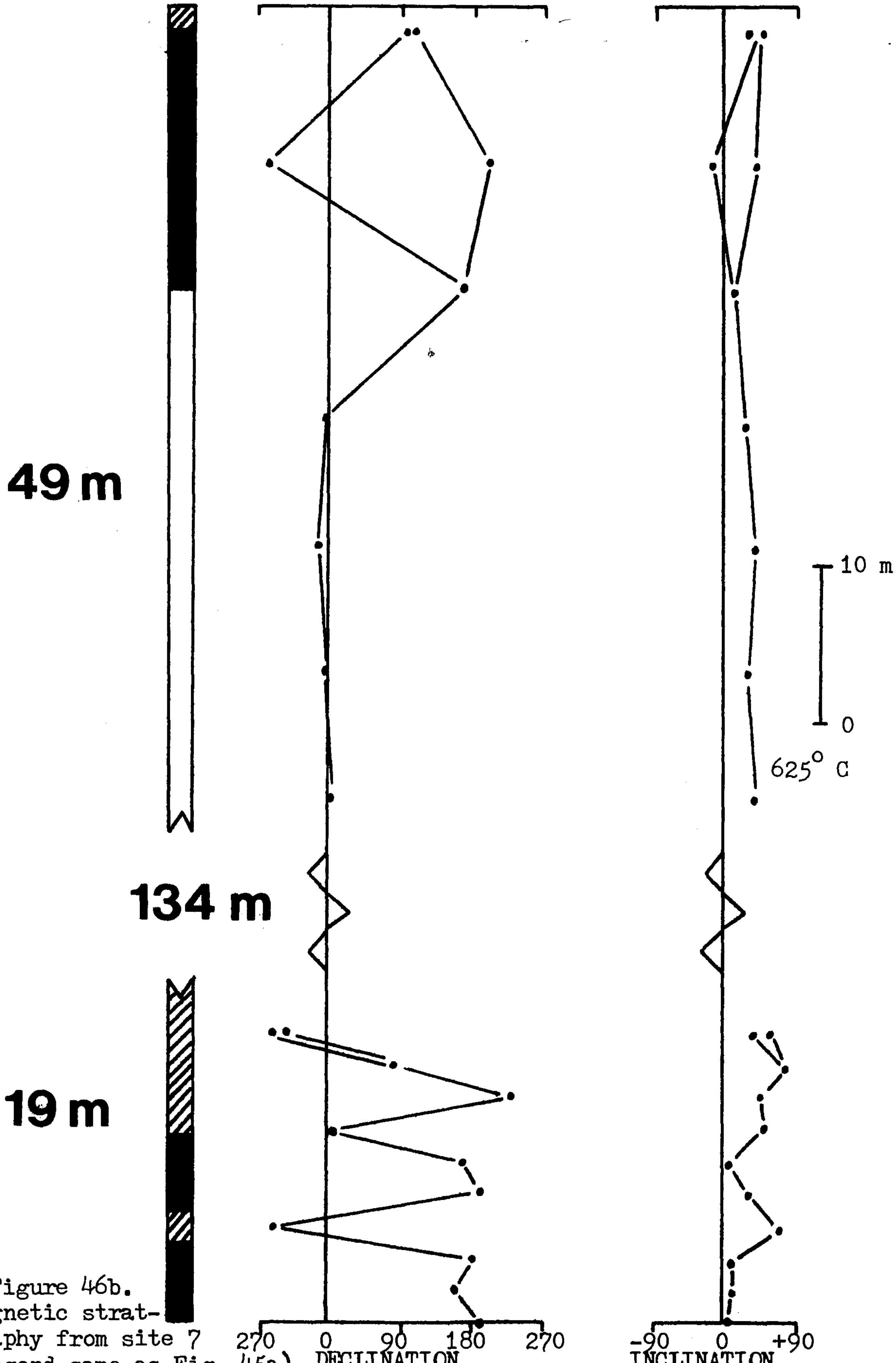


Figure 46b.
Magnetic stratigraphy from site 7
(legend same as Fig. 45a).

primarily due to hematite. A possible reversal was recorded, but can not be substantiated using these mixed directions.

Summarizing the magnetic stratigraphy developed in this study, a large, previously unrecorded reversely magnetized interval was sampled at site 5 in the Brunswick Fm. It was further extended to sites 6 and 9, both less than 5 km away along strike. Using the previously calculated depositional rates for these sediments, the 65 m reversely magnetized interval tells us that the field reversal lasted, at the lower limit, at least 21,700 - 650,000 yr. (Because these samples were of fine-grained lithology, the upper range is more realistic.) This is assuming that the red beds acquired remanence during or shortly after deposition. Site 7 in the Stockton Fm also revealed two shorter reversely magnetized intervals. It is hoped in a short time, these reversals can be correlated with other reversals in the basin, and eventually, with North American and worldwide Triassic units. One point to consider, however, are the results from the chemical leaching aspect of this study. Thermal demagnetization may not be revealing the total magnetic history of these sequences or removing the magnetic overprints which obscure the original remanence directions.

CONCLUSIONS

This red bed paleomagnetic study conducted in the Newark-Gettysburg basin consisted of three parts. First, two demagnetization procedures, chemical leaching and stepwise thermal treatment, were applied to the various sedimentary lithologies found within the basin. Secondly, these two procedures were applied to a selected stratigraphic section to note variations in intensities and directions within any one time horizon. Finally, several magnetic stratigraphic sections were developed in the Brunswick and Stockton Formations to aid in the magnetic correlation of this basin with other worldwide Triassic units. Conclusions are as follows:

1. The red beds from this Triassic basin appeared well-behaved to standard thermal treatment - NRM directions improved to a better Triassic position upon heating. Two pole positions calculated from sites 15 (N=16) and 5 (N=29) yielded after thermal treatment 63.8° N, 107.3° E and 55.5° N, 115.1° E. These are well in agreement with other Triassic poles calculated for North America.

2. On the basis of chemical leaching, however, the samples displayed three behaviors. The first behavior showed little to no change in direction with leaching. The second behavior had initial directions flip to antipodal positions. Apparently these samples had recorded both Triassic normal and reversed polarities. The third behavior had Triassic directions leached out, leaving a residual present-day direction. The three behaviors observed were most likely due to the time and mode of acquisition of the mineral hematite. Some red beds from this basin may be unique in that they recorded two Triassic polarities. Their use in magnetic stratigraphies would invalidate results. All magnetic stratigraphy from the basin can not be revoked as unreliable unless <u>all</u> of the red beds are shown to have recorded <u>dual</u> polarities.

3. Several previously unreported reversely magnetized intervals were noted from the magnetic stratigraphy developed. Site 5 in the Brunswick Fm had a reversal interval of 65 m. If remanence was acquired during or shortly after deposition, this field reversal lasted at least 21,700 - 650,000 yrs. The same reversal interval was also extended to sites 6 and 9, all along strike within 5 km of one another.

Finally, site 7, also yielded two shorter reversely magnetized intervals in the Stockton Fm. It is hoped that shortly, these reversals will be correlated with other reversals within the basin, and ultimately to the Mesozoic magnetic chronology.

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APPENDIX 1

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
1-3-1	NRM	N	.6	35.9	354.9	29.4	NA	87.853
1-3-1	NRMH	N	358.7	35.7	353.1	29.0	1.00	88.387
1-3-1	5 DAYS	N	359.9	33.9	354.7	27.3	.97	86.711
1-3-1	10 DAYS	N	359.5	34.2	354.2	27.6	1.01	92.647
1-3-1	20 DAYS	N	.2	31.5	355.4	25.0	.97	93.574
1-3-1	30 DAYS	N	.2	33.9	354.9	27.3	.91	88.535
1-3-1	40 DAYS	N	359.2	33.8	354.0	27.1	.94	95.111
1-3-1	265 C	N	359.1	35.0	353.7	28.3	.93	93.809
1-3-1	WS/D FF	N	.6	33.6	355.4	27.0	.94	95.500
1-3-1	380 C	N	358.0	33.9	352.9	27.2	.82	82.901
1-3-3	NRM-1	N	2.5	25.2	358.8	19.0	NA	80.499
1-3-3	NRM-2	N	5.0	23.2	1.5	17.3	1.00	90.035
1-3-3	265 C	N	4.1	21.2	.9	15.2	.95	85.657
1-3-3	400 C	N	4.3	22.8	.9	16.9	.86	77.972
1-3-3	530 C	N	4.8	22.6	1.4	16.7	.34	30.680
1-3-3	600 C	M	334.0	-6.0	332.7	-16.8	.02	2.166

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
2-1-2	NRM	N	4.9	30.7	.2	20.5	NA	5.259
2-1-2	NRMH	N	3.8	31.5	359.0	21.2	1.00	5.354
2-1-2	5 DAYS	N	8.6	30.7	3.4	21.0	.90	4.945
2-1-2	10 DAYS	N	9.0	36.4	2.6	26.6	.64	3.625
2-1-2	20 DAYS	N	8.7	17.3	6.2	8.0	.43	2.473
2-1-2	30 DAYS	N	1.6	35.0	356.3	24.3	.32	1.883
2-1-2	40 DAYS	N	5.3	43.2	357.8	32.8	.28	1.702
2-1-2	265 C	N	4.4	32.2	359.4	21.9	.21	1.268
2-1-2	380 C	N	12.5	36.6	5.5	27.2	.18	1.092
2-1-1	NRM-1	N	11.7	40.4	3.9	30.8	NA	4.997
2-1-1	NRM-2	N	10.3	38.1	3.2	28.4	1.00	5.250
2-1-1	265 C	N	16.8	31.2	10.5	22.6	.85	4.462
2-1-1	400 C	N	15.1	30.1	9.3	21.4	.65	3.447
2-1-1	530 C	N	14.9	27.8	9.6	19.2	.61	3.205
2-1-1	600 C	N	.5	38.0	354.8	27.2	.26	1.365

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
2-2-1	NRM	N	9.9	46.7	.6	36.7	NA	3.040
2-2-1	NRMH	N	6.1	52.9	355.6	42.3	1.00	2.923
2-2-1	5 DAYS	M	125.1	4.9	119.6	19.5	1.04	3.115
2-2-1	10 DAYS	N	356.0	50.4	348.1	38.9	.29	.881
2-2-1	20 DAYS	N	4.2	60.7	351.2	49.7	.30	.939
2-2-1	30 DAYS	R	136.9	-5.2	133.7	9.3	.94	2.933
2-2-1	40 DAYS	N	4.9	57.9	352.9	47.0	.24	.750
2-2-1	265 C	N	19.5	51.9	6.5	43.0	.13	.424
2-2-1	WS/D FF	N	6.6	42.5	359.0	32.2	.14	.430
2-2-1	388 C	M	48.3	47.9	30.9	44.2	.07	.234
2-2-2	NRM-1	N	16.6	45.6	6.4	36.5	NA	3.150
2-2-2	NRM-2	N	20.6	42.8	10.5	34.3	1.00	3.149
2-2-2	265 C	N	26.5	40.7	16.0	33.2	.65	2.056
2-2-2	400 C	N	23.8	35.4	15.4	27.8	.70	2.204
2-2-2	530 C	N	10.9	30.5	5.5	21.2	.51	1.609
2-2-2	600 C	N	2.4	35.4	357.0	24.8	.44	1.410

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
3-1-3	NRM	M	249.0	18.4	243.1	7.9	NA	4.792
3-1-3	NRMH	M	246.8	24.5	242.8	13.9	1.00	4.383
3-1-3	5 DAYS	M	234.1	18.3	231.2	10.8	1.08	4.869
3-1-3	10 DAYS	M	255.7	15.4	248.0	3.9	1.43	6.498
3-1-3	20 DAYS	M	257.4	11.8	248.6	.2	1.32	6.115
3-1-3	30 DAYS	M	234.9	23.2	233.1	15.1	.54	2.575
3-1-3	40 DAYS	M	261.0	10.3	251.5	-1.8	1.12	5.546
3-1-3	265 C	M	225.8	4.8	221.3	.8	.59	2.928
3-1-3	380 C	R	220.1	-.7	215.4	-2.6	.63	3.114
3-1-2	NRM-1	M	260.1	34.0	255.9	21.1	NA	4.465
3-1-2	NRM-2	M	262.9	29.5	257.2	16.3	1.00	4.891
3-1-2	265 C	M	257.5	15.0	249.4	3.2	1.45	7.093
3-1-2	400 C	M	235.3	9.8	230.0	2.9	.88	4.352
3-1-2	530 C	M	225.2	4.0	220.6	.2	1.04	5.131
3-1-2	600 C	R	216.8	-2.1	212.4	-3.0	1.20	5.901

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-6-1	NRM-1	M	184.1	15.3	186.7	20.8	NA	5.608
5-6-1	NRM-2	M	184.2	9.7	186.0	15.2	NA	5.839
5-6-1	NRMH	M	167.1	7.8	168.0	16.3	1.00	8.105
5-6-1	5 DAYS	M	181.8	5.0	182.9	11.1	.75	6.837
5-6-1	10 DAYS	M	180.0	19.4	183.3	25.7	.35	3.312
5-6-1	20 DAYS	M	168.5	51.6	178.5	60.0	.13	1.400
5-6-1	30 DAYS	M	146.9	82.3	280.9	86.5	.09	.996
5-6-1	40 DAYS	N	20.8	66.4	2.5	60.4	.09	1.063
5-6-1	265 C	M	48.9	66.2	23.4	63.4	.07	.783
5-6-1	WS/D FF	M	47.0	55.1	29.1	52.3	.06	.657
5-6-1	388 C	M	54.7	72.3	20.3	70.0	.05	.608
5-6-3	NRM-1	R	180.1	-9.1	179.3	-2.6	NA	9.229
5-6-3	NRM-2	R	180.2	-10.6	179.2	-4.1	NA	9.345
5-6-3	NRM-3	R	178.8	-7.8	178.2	-1.2	1.00	9.350
5-6-3	265 C	R	178.5	-13.3	177.1	-6.6	1.03	9.638
5-6-3	400 C	R	180.7	-15.3	179.1	-8.8	.96	9.010

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-6-3	530 C	R	180.2	-15.3	178.6	-8.8	.94	8.869
5-6-3	600 C	R	183.9	-17.7	181.8	-11.5	.99	9.342

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-6-4	NRM	R	176.6	-1.9	176.8	5.0	NA	5.726
5-6-4	NRMH	R	177.5	-3.8	177.4	3.0	1.00	6.436
5-6-4	5 DAYS	M	176.9	3.0	177.8	9.9	.49	3.600
5-6-4	15 DAYS	M	148.7	50.2	150.8	62.1	.14	1.156
5-6-4	25 DAYS	N	27.1	70.2	3.9	64.7	.11	.915
5-6-4	35 DAYS	N	30.0	64.3	10.8	59.2	.15	1.365
5-6-4	265 C	N	38.0	58.2	20.5	54.2	.11	.972
5-6-4	WS/D FF	N	40.4	57.1	23.0	53.4	.10	.902
5-6-4	388 C	N	35.6	58.3	18.7	53.9	.08	.743
5-6-3	NRM-1	R	180.1	-9.1	179.3	-2.6	NA	9.229
5-6-3	NRM-2	R	180.2	-10.6	179.2	-4.1	NA	9.345
5-6-3	NRM-3	R	178.8	-7.8	178.2	-1.2	1.00	9.350
5-6-3	265 C	R	178.5	-13.3	177.1	-6.6	1.03	9.638
5-6-3	400 C	R	180.7	-15.3	179.1	-8.8	.96	9.010
5-6-3	530 C	R	180.2	-15.3	178.6	-8.8	.94	8.869
5-6-3	600 C	R	183.9	-17.7	181.8	-11.5	.99	9.342

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
6-1-2	NRM	M	178.9	14.5	179.8	21.0	NA	7.587
6-1-2	NRMH	M	180.4	14.0	181.3	20.3	1.00	7.598
6-1-2	5 DAYS	M	178.8	13.1	179.6	19.5	.95	8.245
6-1-2	10 DAYS	M	180.3	13.9	181.2	20.2	.57	5.145
6-1-2	20 DAYS	M	179.4	24.9	180.9	31.3	.25	2.406
6-1-2	30 DAYS	M	179.8	42.8	182.9	49.1	.10	.969
6-1-2	40 DAYS	M	170.8	56.5	174.2	63.4	.08	.771
6-1-2	265 C	M	176.7	41.0	179.3	47.6	.07	.710
6-1-2	WS/D FF	M	168.8	31.6	169.9	38.6	.09	.882
6-1-2	380 C	M	181.8	35.3	184.3	41.6	.08	.760
6-1-1	NRM-1	M	178.2	12.0	179.0	18.5	NA	7.420
6-1-1	NRM-2	M	178.4	14.0	179.2	20.5	1.00	7.412
6-1-1	265 C	M	179.0	12.1	179.8	18.6	1.05	7.769
6-1-1	400 C	M	177.5	11.0	178.1	17.6	1.07	7.937
6-1-1	530 C	M	177.7	8.7	178.2	15.2	.97	7.230
6-1-1	600 C	M	175.6	9.9	176.2	16.5	1.05	7.822

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
6-2-3	NRM	M	218.6	41.7	223.8	44.2	NA	1.723
6-2-3	NRMH	M	216.8	40.3	221.8	43.1	1.00	1.657
6-2-3	5 DAYS	M	221.5	21.2	223.4	23.6	.85	1.843
6-2-3	10 DAYS	M	226.4	29.3	229.4	31.1	.25	.542
6-2-3	20 DAYS	M	206.3	54.2	214.4	58.0	.14	.353
6-2-3	30 DAYS	M	221.3	52.1	229.3	54.2	.13	.333
6-2-3	40 DAYS	M	186.1	66.1	196.7	71.8	.14	.361
6-2-3	265 C	M	208.1	38.8	212.6	42.5	.11	.273
6-2-3	WS/D FF	M	212.4	50.5	219.6	53.7	.12	.295
6-2-3	380 C	M	198.9	42.4	203.7	47.0	.09	.217
6-1-1	NRM-1	M	178.2	12.0	179.0	18.5	NA	7.420
6-1-1	NRM-2	M	178.4	14.0	179.2	20.5	1.00	7.412
6-1-1	265 C	M	179.0	12.1	179.8	18.6	1.05	7.769
6-1-1	400 C	M	177.5	11.0	178.1	17.6	1.07	7.937
6-1-1	530 C	M	177.7	8.7	178.2	15.2	.97	7.230
6-1-1	600 C	M	175.6	9.9	176.2	16.5	1.05	7.822

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
7-1-2	NRM	M	187.9	30.1	192.1	37.6	NA	3.878
7-1-2	NRMH	M	180.8	40.4	186.3	48.7	1.00	3.213
7-1-2	5 DAYS	N	317.3	49.2	318.1	40.0	.68	2.310
7-1-2	10 DAYS	N	335.7	34.8	334.6	25.2	.67	2.333
7-1-2	20 DAYS	N	339.2	23.7	338.3	14.0	.79	2.840
7-1-2	30 DAYS	M	174.1	50.2	180.6	59.3	.24	.870
7-1-2	40 DAYS	M	179.7	45.3	186.0	53.8	.22	.818
7-1-2	265 C	M	184.1	36.7	189.2	44.6	.21	.766
7-1-2	388 C	N	345.5	11.9	345.0	2.3	.70	2.607
7-1-2	530 C	M	191.4	11.4	193.0	18.6	.26	.948
7-1-1	NRM-1	M	151.4	65.5	151.1	76.0	NA	2.606
7-1-1	NRM-2	M	147.1	69.5	142.5	79.9	1.00	2.502
7-1-1	268 C	M	161.1	52.5	164.2	62.7	.84	2.100
7-1-1	400 C	M	176.8	29.3	179.9	38.2	.91	2.285
7-1-1	530 C	M	175.1	14.6	176.6	23.7	1.05	2.632
7-1-1	600 C	R	171.6	-.7	171.8	8.7	.93	2.351

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
8-1-2	NRM	R	142.6	-32.5	145.5	-20.8	NA	2.147
8-1-2	NRMH	R	141.8	-30.4	144.5	-18.7	1.00	2.016
8-1-2	5 DAYS	R	141.9	-36.5	145.4	-24.8	.92	1.900
8-1-2	10 DAYS	M	123.9	-50.4	132.8	-40.6	.55	1.142
8-1-2	20 DAYS	M	120.1	-52.0	130.2	-42.7	.34	.719
8-1-2	30 DAYS	M	324.7	-78.5	232.3	-84.5	1.51	3.208
8-1-2	40 DAYS	M	115.1	-65.3	132.1	-56.2	.20	.427
8-1-2	265 C	M	88.2	-62.1	109.8	-57.8	.18	.398
8-1-2	388 C	M	89.1	-57.5	107.3	-53.4	.18	.396
8-1-2	530 C	M	91.3	-33.3	99.2	-29.9	.07	.158
8-1-3	NRM-1	R	159.5	-29.8	160.5	-17.0	NA	3.172
8-1-3	NRM-2	R	159.4	-31.5	160.5	-18.7	1.00	3.058
8-1-3	265 C	R	159.0	-36.4	160.3	-23.6	.95	2.940
8-1-3	400 C	R	162.6	-30.5	163.3	-17.6	.91	2.840
8-1-3	530 C	R	165.5	-30.4	165.9	-17.4	.93	2.897
8-1-3	600 C	R	154.2	-30.9	155.8	-18.4	.90	2.790

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
10-2-1	NRM	R	170.1	-.0	170.0	4.6	NA	2.332
10-2-1	NRMH	M	141.9	2.4	137.4	11.1	1.00	4.934
10-2-1	5 DAYS	R	176.7	-.5	176.9	3.1	.42	2.346
10-2-1	10 DAYS	M	191.1	43.4	199.0	43.1	.13	.780
10-2-1	20 DAYS	N	16.5	60.1	1.5	57.0	.11	.710
10-2-1	30 DAYS	N	16.6	57.5	2.9	54.4	.13	.848
10-2-1	40 DAYS	M	113.2	10.8	102.2	21.0	.46	3.147
10-2-1	265 C	N	22.5	40.8	13.6	38.5	.08	.580
10-2-1	380 C	N	22.2	49.4	10.9	46.9	.06	.420
10-2-4	NRM-1	R	169.6	-3.2	169.1	1.4	NA	4.473
10-2-4	NRM-2	R	167.3	-3.4	166.6	1.5	1.00	5.002
10-2-4	265 C	R	170.1	-8.5	168.8	-4.0	1.08	5.419
10-2-4	400 C	R	172.1	-13.3	170.3	-9.2	1.10	5.492
10-2-4	530 C	R	175.7	-18.1	173.2	-14.5	1.14	5.735
10-2-4	600 C	R	177.9	-18.7	175.4	-15.3	1.22	6.155

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
11-1-1	NRM	N	326.6	14.9	321.5	1.2	NA	1.087
11-1-1	NRMH	N	329.8	49.4	317.7	37.1	1.00	1.000
11-1-1	5 DAYS	M	311.5	35.2	302.3	20.7	.64	.642
11-1-1	10 DAYS	M	311.9	39.4	302.3	25.0	.52	.519
11-1-1	20 DAYS	M	307.7	37.6	298.3	22.7	.52	.528
11-1-1	30 DAYS	M	302.3	41.5	292.8	26.3	.49	.497
11-1-1	40 DAYS	M	301.5	40.9	292.1	25.6	.46	.470
11-1-1	265 C	M	312.3	29.5	303.6	14.7	.27	.276
11-1-1	380 C	M	271.7	13.3	261.3	-2.9	2.58	2.610
11-1-1	530 C	N	37.9	35.5	22.4	36.0	.07	.070
11-1-2	NRM-1	N	359.2	49.9	343.7	41.8	NA	.531
11-1-2	NRM-2	N	344.6	44.5	333.0	34.4	1.00	.591
11-1-2	265 C	N	.9	29.5	353.1	22.7	.87	.514
11-1-2	400 C	N	355.8	21.9	350.7	14.4	.76	.448
11-1-2	530 C	M	272.7	13.2	262.1	-3.0	3.95	2.341
11-1-2	600 C	M	270.0	9.8	259.1	-6.1	3.58	2.124

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
13-1-1	NRM	M	52.2	76.1	1.7	72.2	NA	1.439
13-1-1	NRMH	M	77.5	68.0	34.8	70.9	1.00	1.546
13-1-1	5 DAYS	M	93.7	59.5	61.9	67.8	.60	.940
13-1-1	10 DAYS	M	91.3	65.2	51.9	72.1	.42	.654
13-1-1	20 DAYS	M	148.9	70.9	185.4	82.9	.35	.556
13-1-1	30 DAYS	M	143.1	66.0	156.5	80.1	.22	.353
13-1-1	40 DAYS	M	151.7	74.6	214.2	84.2	.23	.364
13-1-1	265 C	M	171.9	64.3	200.5	71.4	.17	.278
13-1-1	380 C	M	168.5	53.5	184.9	62.9	.21	.344
13-1-2	NRM-1	N	26.6	41.3	14.8	36.1	NA	1.373
13-1-2	NRM-2	N	22.6	17.6	17.8	13.6	1.00	4.597
13-1-2	265 C	N	29.4	30.8	20.2	26.8	.29	1.337
13-1-2	400 C	N	30.6	24.8	22.7	21.4	.18	.828
13-1-2	530 C	M	50.1	15.0	40.9	16.4	.16	.720
13-1-2	600 C	M	39.3	-50.5	49.2	-45.9	.09	.420

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
14-2-4	NRM	M	135.5	23.3	132.4	43.8	NA	3.952
14-2-4	NRMH	M	137.3	19.6	134.5	39.7	1.00	4.093
14-2-4	5 DAYS	M	85.5	18.7	68.3	32.3	.92	3.836
14-2-4	10 DAYS	M	72.0	25.0	53.7	34.2	.79	3.320
14-2-4	20 DAYS	M	53.5	12.6	42.1	18.3	.65	2.792
14-2-4	30 DAYS	N	41.9	10.1	33.7	13.1	.60	2.582
14-2-4	40 DAYS	M	112.8	49.6	92.2	68.9	.21	.916
14-2-4	265 C	N	38.3	6.6	31.9	9.1	.06	.249
14-2-4	380 C	M	123.2	31.9	113.7	53.0	.18	.782
14-2-4	530 C	M	123.7	31.7	114.6	52.8	.16	.726
14-2-1	NRM-1	M	157.1	21.7	162.4	37.0	NA	6.297
14-2-1	NRM-2	M	156.2	23.3	161.7	39.0	1.00	7.059
14-2-1	265 C	M	159.7	14.4	163.4	28.7	1.03	7.304
14-2-1	400 C	M	157.9	14.4	161.2	29.3	1.04	7.388
14-2-1	530 C	M	169.6	9.0	173.1	19.9	1.15	8.154
14-2-1	600 C	M	170.0	4.4	172.3	15.3	1.29	9.150

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-4-1	NRM	N	14.8	51.4	11.5	36.8	NA	.955
15-4-1	NRMH	N	4.1	61.0	2.9	46.0	1.00	.904
15-4-1	5 DAYS	N	28.3	63.0	19.2	49.2	.88	.842
15-4-1	10 DAYS	N	9.5	52.7	7.3	37.9	.98	.961
15-4-1	20 DAYS	N	8.3	56.8	6.1	42.0	1.10	1.124
15-4-1	30 DAYS	N	2.3	58.5	1.6	43.5	.86	.912
15-4-1	40 DAYS	N	27.1	56.4	20.0	42.6	1.05	1.163
15-4-1	265 C	N	18.6	52.9	14.3	38.5	.72	.811
15-4-1	380 C	N	347.2	48.0	349.8	33.3	.32	.358
15-4-2	NRM-1	N	19.9	58.0	14.4	43.6	NA	.984
15-4-2	NRM-2	M	70.7	30.7	63.4	24.8	1.00	2.979
15-4-2	265 C	N	31.6	51.9	24.5	38.6	.25	.736
15-4-2	400 C	N	359.2	31.4	359.3	16.4	.10	.295
15-4-2	530 C	M	106.3	14.0	102.1	17.7	.09	.275
15-4-2	600 C	N	40.2	30.8	35.9	18.9	.44	1.337

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
16-2-2	NRM	N	3.8	50.2	352.9	43.5	NA	7.222
16-2-2	NRMH	N	25.3	40.3	14.4	36.0	1.00	8.390
16-2-2	5 DAYS	N	5.0	44.6	355.7	38.2	.68	6.306
16-2-2	10 DAYS	N	9.3	48.8	358.1	42.6	.45	4.367
16-2-2	20 DAYS	N	15.0	48.5	3.0	42.8	.25	2.572
16-2-2	30 DAYS	N	7.4	56.0	353.6	49.3	.16	1.685
16-2-2	40 DAYS	N	358.3	51.6	347.6	44.4	.12	1.409
16-2-2	265 C	N	7.5	47.6	357.0	41.3	.09	1.079
16-2-2	380 C	M	55.1	6.8	46.2	10.5	.31	3.510
16-2-1	NRM-1	N	7.3	46.8	357.1	40.5	1.00	7.770
16-2-1	423 C	N	7.4	49.2	356.3	42.8	.57	4.453
16-2-1	560 C	N	6.1	53.4	353.7	46.8	.35	2.771

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
16-2-2	NRM	N	3.8	50.2	352.9	43.5	NA	7.222
16-2-2	NRMH	N	25.3	40.3	14.4	36.0	1.00	8.390
16-2-2	5 DAYS	N	5.0	44.6	355.7	38.2	.68	6.306
16-2-2	10 DAYS	N	9.3	48.8	358.1	42.6	.45	4.367
16-2-2	20 DAYS	N	15.0	48.5	3.0	42.8	.25	2.572
16-2-2	30 DAYS	N	7.4	56.0	353.6	49.3	.16	1.685
16-2-2	40 DAYS	N	358.3	51.6	347.6	44.4	.12	1.409
16-2-2	265 C	N	7.5	47.6	357.0	41.3	.09	1.079
16-2-2	380 C	M	55.1	6.8	46.2	10.5	.31	3.510
16-2-3	NRM-1	N	5.9	48.7	355.2	42.2	NA	7.378
16-2-3	NRM-2	N	9.1	48.3	358.1	42.1	1.00	8.072
16-2-3	265 C	N	11.5	46.5	.8	40.6	.75	6.085
16-2-3	400 C	N	8.8	48.7	357.7	42.4	.55	4.440
16-2-3	530 C	N	8.3	49.6	357.0	43.2	.37	2.984
16-2-3	600 C	N	357.1	77.7	329.3	68.8	.48	3.883

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
17-1-1	NRM	N	19.0	35.9	15.8	32.3	NA	1.606
17-1-1	NRMH	N	8.2	43.9	5.2	39.9	1.00	1.704
17-1-1	5 DAYS	N	22.6	36.3	19.1	32.8	.50	1.051
17-1-1	10 DAYS	N	11.1	43.4	7.8	39.4	.12	.267
17-1-1	20 DAYS	N	20.7	39.5	17.1	35.8	.06	.139
17-1-1	30 DAYS	N	357.1	51.5	354.1	47.3	.07	.178
17-1-1	40 DAYS	M	70.6	36.8	62.8	37.1	.10	.262
17-1-1	265 C	M	48.1	41.2	41.5	39.2	.05	.133
17-1-1	380 C	N	33.9	60.1	25.2	57.0	.03	.081
17-1-3	NRM-1	N	13.6	32.5	11.2	28.7	NA	2.056
17-1-3	NRM-2	N	22.0	31.5	19.0	28.0	1.00	2.260
17-1-3	265 C	N	20.0	26.7	17.6	23.3	.81	1.837
17-1-3	400 C	N	20.6	34.9	17.4	31.3	.52	1.174
17-1-3	530 C	N	36.2	47.1	30.0	44.2	.35	.796
17-1-3	600 C	N	324.1	6.3	322.4	1.4	.16	.365

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
18-1-1	NRM	N	3.3	40.8	358.0	37.7	NA	2.720
18-1-1	NRMH	N	3.7	42.0	358.2	38.8	1.00	2.605
18-1-1	5 DAYS	N	345.0	32.3	340.9	29.0	.66	2.203
18-1-1	10 DAYS	N	352.6	36.6	348.2	33.5	.22	.784
18-1-1	20 DAYS	N	44.1	24.9	35.7	24.5	.09	.379
18-1-1	30 DAYS	N	8.3	41.9	2.5	38.9	.09	.395
18-1-1	40 DAYS	N	3.5	44.3	357.5	41.2	.10	.435
18-1-1	265 C	N	5.4	38.3	.5	35.3	.08	.348
18-1-1	380 C	N	21.1	47.1	12.7	44.2	.05	.219
18-1-2	NRM-1	N	358.8	38.2	354.2	35.0	NA	3.113
18-1-2	NRM-2	N	2.8	34.4	358.6	31.4	1.00	3.156
18-1-2	423 C	N	359.5	36.6	355.1	33.5	.44	1.318
18-1-2	560 C	N	358.3	30.5	354.9	27.4	.30	.885

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
18-1-1	NRM	N	3.3	40.8	358.0	37.7	NA	2.720
18-1-1	NRMH	N	3.7	42.0	358.2	38.8	1.00	2.605
18-1-1	5 DAYS	N	345.0	32.3	340.9	29.0	.66	2.203
18-1-1	10 DAYS	N	352.6	36.6	348.2	33.5	.22	.784
18-1-1	20 DAYS	N	44.1	24.9	35.7	24.5	.09	.379
18-1-1	30 DAYS	N	8.3	41.9	2.5	38.9	.09	.395
18-1-1	40 DAYS	N	3.5	44.3	357.5	41.2	.10	.435
18-1-1	265 C	N	5.4	38.3	.5	35.3	.08	.348
18-1-1	380 C	N	21.1	47.1	12.7	44.2	.05	.219
18-1-4	NRM-1	N	3.7	44.1	357.7	41.0	NA	2.747
18-1-4	NRM-2	N	1.8	40.9	356.6	37.7	1.00	2.876
18-1-4	265 C	N	2.9	34.2	358.7	31.1	.70	2.026
18-1-4	400 C	N	354.3	42.6	348.9	39.4	.50	1.453
18-1-4	530 C	N	14.1	48.5	6.3	45.4	.31	.896

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
18-1-3	NRM	N	358.6	39.2	353.8	36.1	NA	3.092
18-1-3	NRMH	N	4.2	39.9	359.1	36.8	1.00	2.833
18-1-3	5 DAYS	N	11.4	12.3	9.6	10.2	1.62	5.906
18-1-3	10 DAYS	N	13.1	9.7	11.4	7.9	1.08	4.180
18-1-3	20 DAYS	N	16.7	6.8	15.0	5.5	.98	4.456
18-1-3	30 DAYS	N	2.9	46.1	356.6	42.9	.09	.420
18-1-3	40 DAYS	N	15.5	9.2	13.6	7.6	.89	4.157
18-1-3	265 C	N	355.0	48.7	348.5	45.5	.07	.321
18-1-3	WS/D FF	N	22.4	37.9	15.8	35.3	.07	.322
18-1-3	380 C	N	357.0	41.5	351.8	38.3	.04	.172
18-1-4	NRM-1	N	3.7	44.1	357.7	41.0	NA	2.747
18-1-4	NRM-2	N	1.8	40.9	356.6	37.7	1.00	2.876
18-1-4	265 C	N	2.9	34.2	358.7	31.1	.70	2.026
18-1-4	400 C	N	354.3	42.6	348.9	39.4	.50	1.453
18-1-4	530 C	N	14.1	48.5	6.3	45.4	.31	.896

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
22-4-1	NRM	N	10.5	44.9	5.8	37.4	NA	7.211
22-4-1	NRMH	N	12.7	48.3	7.1	40.9	1.00	7.078
22-4-1	5 DAYS	N	12.2	43.1	7.5	35.8	1.07	7.656
22-4-1	10 DAYS	N	9.5	42.5	5.3	35.0	.99	7.300
22-4-1	20 DAYS	N	8.9	40.6	5.0	33.0	1.13	8.559
22-4-1	30 DAYS	N	12.4	42.6	7.8	35.3	1.10	8.475
22-4-1	40 DAYS	N	10.8	40.9	6.6	33.5	1.13	8.903
22-4-1	265 C	N	17.3	29.6	14.0	22.8	1.24	9.837
22-4-1	380 C	N	10.1	39.4	6.2	32.0	.77	6.127
22-4-2	NRM-1	N	6.3	42.0	2.5	34.3	NA	6.960
22-4-2	NRM-2	N	8.1	40.9	4.2	33.3	1.00	7.512
22-4-2	423 C	N	3.7	46.3	359.6	38.4	.45	3.409
22-4-2	560 C	R	210.3	-9.9	208.7	-5.0	.12	.912

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
22-4-1	NRM	N	10.5	44.9	5.8	37.4	NA	7.211
22-4-1	NRMH	N	12.7	48.3	7.1	40.9	1.00	7.078
22-4-1	5 DAYS	N	12.2	43.1	7.5	35.8	1.07	7.656
22-4-1	10 DAYS	N	9.5	42.5	5.3	35.0	.99	7.300
22-4-1	20 DAYS	N	8.9	40.6	5.0	33.0	1.13	8.559
22-4-1	30 DAYS	N	12.4	42.6	7.8	35.3	1.10	8.475
22-4-1	40 DAYS	N	10.8	40.9	6.6	33.5	1.13	8.903
22-4-1	265 C	N	17.3	29.6	14.0	22.8	1.24	9.837
22-4-1	380 C	N	10.1	39.4	6.2	32.0	.77	6.127
22-4-3	NRM-1	N	9.4	47.5	4.4	39.9	NA	7.086
22-4-3	NRM-2	N	11.4	44.8	6.6	37.4	1.00	7.565
22-4-3	265 C	N	14.2	44.3	9.2	37.1	.93	7.041
22-4-3	400 C	N	3.8	53.5	358.6	45.6	.68	5.188
22-4-3	530 C	M	232.3	40.0	238.3	40.4	.18	1.346
22-4-3	600 C	M	195.4	65.9	213.3	71.2	.18	1.383

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
23-3-1	NRM	M	333.3	-43.8	308.9	-65.4	NA	.216
23-3-1	NRMH	M	74.2	-20.9	85.8	-25.7	1.00	3.703
23-3-1	5 DAYS	N	335.4	25.7	337.9	.8	.06	.248
23-3-1	10 DAYS	N	43.4	56.9	27.1	34.5	.02	.094
23-3-1	20 DAYS	N	359.6	10.9	359.6	-16.1	.62	2.457
23-3-1	30 DAYS	M	62.9	43.7	46.6	27.8	.02	.096
23-3-1	40 DAYS	M	93.7	71.2	37.9	58.5	.02	.076
23-3-1	265 C	M	76.2	57.1	46.8	43.6	.04	.174
23-3-1	380 C	M	121.0	58.4	72.0	61.8	.02	.075
23-3-3	NRM-1	N	41.3	51.7	28.0	29.2	NA	.132
23-3-3	NRM-2	M	61.5	30.1	51.9	15.1	1.00	.185
23-3-3	265 C	M	78.6	6.8	76.8	.9	1.04	.192
23-3-3	400 C	M	75.0	12.6	71.0	4.6	.32	.060
23-3-3	530 C	R	144.4	-62.5	160.0	-38.3	.55	.103
23-3-3	600 C	M	72.7	-18.2	83.1	-23.9	13.44	2.523

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
24-2-4	NRMH	M	10.7	-32.0	.0	-48.3	1.00	.520
24-2-4	5 DAYS	M	53.0	-56.0	74.8	-76.6	1.46	.761
24-2-4	10 DAYS	M	338.2	-58.6	305.4	-60.1	.71	.371
24-2-4	20 DAYS	M	29.5	-70.4	291.6	-85.3	.52	.271
24-2-4	30 DAYS	M	57.2	-61.6	97.0	-80.3	.18	.094
24-2-4	40 DAYS	M	316.5	-67.3	280.1	-60.3	.18	.097
24-2-4	265 C	M	109.9	-83.8	205.7	-71.2	.24	.129
24-2-4	380 C	N	40.1	17.7	43.1	-2.3	.37	.195
24-2-2	NRM-1	N	32.5	56.0	37.9	37.3	NA	.882
24-2-2	NRM-2	N	44.3	54.6	46.9	35.7	1.00	.999
24-2-2	265 C	M	56.9	51.6	57.1	33.0	.65	.654
24-2-2	400 C	M	48.9	51.3	50.7	32.4	.64	.644
24-2-2	530 C	M	64.1	21.1	68.0	2.2	.47	.467
24-2-2	600 C	M	63.7	-10.2	72.6	-30.0	.26	.262

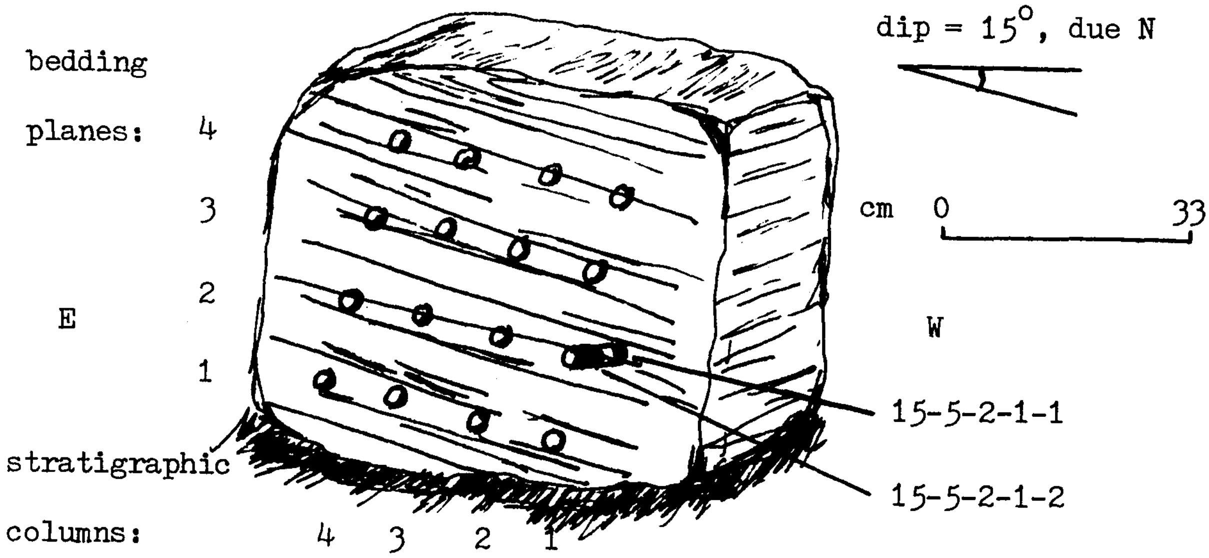
APPENDIX 2

Identification code for specimens collected from sample 15-5

The thirty-one specimens cored from sample 15-5 were identified in the following manner. Each time horizon was given a number from 1 - 4, with 1 indicating the oldest horizon, and 4, the youngest of horizons. Each stratigraphic column then consisted of four time horizons. They were numbered from 1 - 4; the first located originally in the field, West, and fourth located originally to the East in the field. Finally, each individual specimen from a core was numbered 1 or 2, with 1 the deepest drilled specimen and 2 the closest to the exposed surface. An example of the specimen code would be:

15 - 5 - 2 - 1 - 1

where 15-5 indicates site 15, sample 5; 2 indicates bedding horizon 2, the second oldest horizon; 2 indicated the second stratigraphic column located from the West; and 1 indicated the deepest specimen obtained from a core drilled that contained 2 specimens (see Figure below).



APPENDIX 3

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-1-1-1	NRM	N	5.8	53.3	4.4	38.4	NA	4.130
15-5-1-1-1	NRMH	N	1.9	54.3	1.4	39.3	1.00	4.140
15-5-1-1-1	5 DAYS	N	2.6	50.7	2.0	35.7	.86	4.083
15-5-1-1-1	10 DAYS	N	356.1	55.4	357.1	40.5	.43	2.118
15-5-1-1-1	20 DAYS	N	3.7	60.6	2.6	45.7	.15	.823
15-5-1-1-1	30 DAYS	N	2.7	51.3	2.1	36.3	.27	1.458
15-5-1-1-1	40 DAYS	N	26.7	63.7	17.9	49.8	.12	.684
15-5-1-1-1	265 C	N	23.2	62.9	15.8	48.8	.09	.553
15-5-1-1-1	388 C	N	26.5	67.6	16.6	53.6	.06	.365
15-5-1-1-2	NRM-1	N	12.5	50.0	9.8	35.3	NA	4.298
15-5-1-1-2	NRM-2	N	11.5	45.4	9.3	30.6	1.00	4.604
15-5-1-1-2	268 C	N	10.9	47.9	8.7	33.1	.77	3.539
15-5-1-1-2	400 C	N	9.0	49.9	7.0	35.0	.66	3.064
15-5-1-1-2	530 C	N	18.7	46.2	15.1	31.9	.40	1.928
15-5-1-1-2	600 C	N	13.9	44.5	11.4	29.9	.40	1.862

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-1-2-1	NRM	N	3.0	53.7	2.3	38.7	NA	7.767
15-5-1-2-1	NRMH	M	72.8	58.2	53.6	51.4	1.00	8.065
15-5-1-2-1	5 DAYS	N	358.4	47.5	358.8	32.6	.79	7.357
15-5-1-2-1	10 DAYS	N	359.2	53.5	359.4	38.5	.35	3.369
15-5-1-2-1	20 DAYS	N	350.8	45.2	352.5	30.3	.13	1.361
15-5-1-2-1	30 DAYS	N	344.5	53.9	348.3	39.3	.07	.777
15-5-1-2-1	40 DAYS	N	20.4	62.7	13.9	48.4	.06	.682
15-5-1-2-1	265 C	N	.7	51.2	.5	36.2	.06	.625
15-5-1-2-1	388 C	N	7.3	65.6	4.8	50.7	.03	.362
15-5-1-2-2	NRM-1	N	2.2	51.3	1.7	36.3	NA	6.215
15-5-1-2-2	NRM-2	N	3.9	52.1	3.0	37.2	1.00	5.922
15-5-1-2-2	268 C	N	2.2	46.9	1.7	31.9	.85	5.049
15-5-1-2-2	400 C	N	.2	51.6	.1	36.6	.74	4.409
15-5-1-2-2	530 C	N	359.4	45.2	359.5	30.2	.63	3.748
15-5-1-2-2	600 C	N	353.4	45.9	354.6	30.9	.49	2.924

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-1-3-2	NRM	N	5.5	51.2	4.3	36.2	NA	4.554
15-5-1-3-2	NRMH	N	356.0	48.1	356.8	33.2	1.00	4.665
15-5-1-3-2	5 DAYS	N	357.0	45.9	357.5	30.9	.81	4.366
15-5-1-3-2	10 DAYS	N	.3	49.5	.2	34.5	.47	2.661
15-5-1-3-2	20 DAYS	M	132.3	16.2	127.8	25.9	.58	3.605
15-5-1-3-2	30 DAYS	N	346.9	59.2	350.6	44.5	.10	.649
15-5-1-3-2	40 DAYS	N	2.8	71.8	1.6	56.8	.10	.717
15-5-1-3-2	265 C	N	10.0	60.7	7.0	45.9	.08	.583
15-5-1-3-2	388 C	N	326.5	70.9	340.4	57.3	.04	.299
15-5-1-3-1	NRM-1	N	3.7	42.4	3.1	27.4	NA	4.916
15-5-1-3-1	NRM-2	N	3.9	48.8	3.1	33.8	1.00	5.333
15-5-1-3-1	268 C	N	1.7	39.3	1.4	24.3	.82	4.366
15-5-1-3-1	400 C	N	4.0	41.4	3.3	26.4	.70	3.772
15-5-1-3-1	530 C	N	19.7	40.9	16.5	26.6	.51	2.726
15-5-1-3-1	600 C	N	358.1	35.7	358.3	20.7	.46	2.472

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-1-4-1	NRM-1	N	.5	44.1	.4	29.1	NA	4.353
15-5-1-4-1	NRM-2	N	359.7	45.4	359.8	30.4	NA	4.660
15-5-1-4-1	NRM-3	N	4.1	43.7	3.4	28.7	1.00	4.410
15-5-1-4-1	268 C	N	2.7	37.1	2.3	22.1	.87	3.833
15-5-1-4-1	400 C	N	45.4	41.5	38.1	30.3	.72	3.193
15-5-1-4-1	530 C	N	354.9	34.0	355.6	19.0	.57	2.537
15-5-1-4-1	600 C	N	354.0	32.0	354.7	17.1	.40	1.775

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-2-1-2	NRM	N	3.1	20.6	3.0	5.7	NA	12.037
15-5-2-1-2	NRMH	N	1.4	23.0	1.3	8.0	1.00	12.065
15-5-2-1-2	5 DAYS	N	1.6	22.2	1.5	7.2	.90	13.387
15-5-2-1-2	10 DAYS	N	.5	31.5	.4	16.5	.15	2.379
15-5-2-1-2	20 DAYS	N	3.9	50.0	3.1	35.0	.05	.838
15-5-2-1-2	30 DAYS	M	128.1	20.7	122.4	29.4	.19	3.245
15-5-2-1-2	40 DAYS	N	354.7	52.6	355.9	37.6	.04	.747
15-5-2-1-2	265 C	N	3.4	53.8	2.6	38.8	.03	.612
15-5-2-1-2	388 C	N	9.9	51.6	7.7	36.8	.02	.412
15-5-2-1-1	NRM-1	N	7.0	25.5	6.4	10.6	NA	8.475
15-5-2-1-1	NRM-2	N	4.2	27.6	3.8	12.7	1.00	8.834
15-5-2-1-1	268 C	N	4.8	24.3	4.4	9.3	.91	8.025
15-5-2-1-1	400 C	N	3.9	20.8	3.6	5.8	.82	7.308
15-5-2-1-1	530 C	N	4.5	17.4	4.3	2.5	.73	6.539
15-5-2-1-1	600 C	N	4.4	14.5	4.3	-.4	.58	5.212

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-2-2-2	NRM	N	352.4	44.7	353.8	29.8	NA	8.996
15-5-2-2-2	NRMH	N	352.6	42.6	353.9	27.7	1.00	9.759
15-5-2-2-2	5 DAYS	N	345.2	43.8	347.8	29.2	.80	9.440
15-5-2-2-2	10 DAYS	M	78.1	67.0	50.5	60.2	.32	3.965
15-5-2-2-2	20 DAYS	N	355.3	52.4	356.4	37.4	.07	.989
15-5-2-2-2	30 DAYS	N	8.3	52.3	6.4	37.5	.05	.742
15-5-2-2-2	40 DAYS	N	2.5	53.9	1.9	38.9	.05	.730
15-5-2-2-2	265 C	N	5.3	50.9	4.2	35.9	.04	.620
15-5-2-2-2	388 C	N	1.3	48.0	1.0	33.0	.03	.441
15-5-2-2-1	NRM-1	N	340.3	35.8	342.9	21.5	NA	12.884
15-5-2-2-1	NRM-2	N	342.8	35.3	345.1	20.9	1.00	13.214
15-5-2-2-1	268 C	N	339.7	34.5	342.3	20.3	.95	12.516
15-5-2-2-1	400 C	N	339.5	34.9	342.1	20.8	.88	11.671
15-5-2-2-1	530 C	N	338.8	32.0	341.2	17.9	.81	10.698
15-5-2-2-1	600 C	N	338.5	31.9	340.9	17.9	.76	10.049

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-2-3-1	NRM	N	348.2	38.5	350.0	23.7	NA	8.452
15-5-2-3-1	NRMH	N	357.9	36.6	358.2	21.6	1.00	8.629
15-5-2-3-1	5 DAYS	N	32.7	42.7	27.2	29.7	.72	7.754
15-5-2-3-1	10 DAYS	N	355.0	37.1	355.7	22.2	.26	3.031
15-5-2-3-1	20 DAYS	N	17.6	39.7	14.9	25.3	.09	1.162
15-5-2-3-1	30 DAYS	N	6.9	52.0	5.3	37.1	.05	.670
15-5-2-3-1	40 DAYS	N	355.1	52.8	356.3	37.8	.06	.859
15-5-2-3-1	265 C	N	1.8	48.9	1.5	33.9	.04	.568
15-5-2-3-1	388 C	N	17.8	56.5	13.1	42.0	.03	.379
15-5-2-3-2	NRM-1	N	.6	19.6	.6	4.6	NA	15.084
15-5-2-3-2	NRM-2	N	1.0	20.8	.9	5.8	1.00	15.591
15-5-2-3-2	268 C	N	358.7	21.2	358.8	6.2	.96	14.937
15-5-2-3-2	400 C	N	2.0	15.2	1.9	.2	.89	13.913
15-5-2-3-2	530 C	N	358.7	15.2	358.8	.2	.81	12.703

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-2-4-1	NRM	N	332.3	36.2	336.0	22.7	NA	13.080
15-5-2-4-1	NRMH	N	337.7	44.7	341.7	30.6	1.00	12.274
15-5-2-4-1	5 DAYS	N	331.0	34.9	334.7	21.5	1.06	16.812
15-5-2-4-1	10 DAYS	M	299.7	42.6	309.5	34.0	.38	6.159
15-5-2-4-1	20 DAYS	M	298.3	53.0	312.3	44.3	.11	1.979
15-5-2-4-1	30 DAYS	N	5.2	61.8	3.6	46.8	.03	.633
15-5-2-4-1	40 DAYS	N	10.0	61.4	6.9	46.5	.04	.725
15-5-2-4-1	265 C	N	1.2	56.5	.9	41.5	.03	.590
15-5-2-4-1	388 C	N	356.5	49.7	357.3	34.7	.02	.437
15-5-2-4-2	NRM-1	N	352.9	33.9	353.7	19.0	NA	14.417
15-5-2-4-2	NRM-2	N	352.2	35.0	353.2	20.1	1.00	14.968
15-5-2-4-2	268 C	N	354.2	32.6	354.8	17.6	.96	14.442
15-5-2-4-2	400 C	N	352.6	33.8	353.5	18.9	.90	13.558
15-5-2-4-2	530 C	N	353.9	29.4	354.5	14.4	.82	12.397
15-5-2-4-2	600 C	N	350.9	32.6	351.9	17.8	.80	12.102

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-3-1-1	NRM	N	16.8	44.0	13.8	29.6	NA	6.484
15-5-3-1-1	NRMH	N	14.2	44.1	11.7	29.5	1.00	6.355
15-5-3-1-1	5 DAYS	N	15.8	34.8	13.8	20.3	.77	6.069
15-5-3-1-1	10 DAYS	N	21.8	27.8	19.8	13.8	.30	2.540
15-5-3-1-1	20 DAYS	N	13.2	43.7	10.9	29.0	.07	.650
15-5-3-1-1	30 DAYS	N	12.5	49.0	9.9	34.3	.07	.692
15-5-3-1-1	40 DAYS	N	14.6	53.9	11.1	39.2	.07	.710
15-5-3-1-1	265 C	N	12.9	52.3	9.9	37.6	.06	.619
15-5-3-1-1	388 C	M	127.8	13.8	123.8	22.6	.44	4.502
15-5-3-1-2	NRM-1	N	14.8	40.8	12.5	26.2	NA	6.263
15-5-3-1-2	NRM-2	N	14.4	42.4	12.0	27.8	1.00	6.461
15-5-3-1-2	268 C	N	12.5	41.2	10.5	26.5	.84	5.458
15-5-3-1-2	400 C	N	15.4	35.6	13.3	21.0	.69	4.500
15-5-3-1-2	530 C	N	13.6	33.9	11.9	19.2	.44	2.888
15-5-3-1-2	600 C	N	17.5	30.9	15.6	16.5	.37	2.437

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-3-2-1	NRM	N	11.7	29.5	10.5	14.8	NA	6.330
15-5-3-2-1	NRMH	N	11.2	29.0	10.1	14.3	1.00	6.374
15-5-3-2-1	5 DAYS	N	11.3	19.5	10.7	4.8	.78	6.350
15-5-3-2-1	10 DAYS	N	7.4	23.3	6.9	8.4	.18	1.545
15-5-3-2-1	20 DAYS	N	1.6	42.9	1.3	27.9	.07	.638
15-5-3-2-1	30 DAYS	N	29.4	39.1	25.0	25.8	.08	.756
15-5-3-2-1	40 DAYS	N	11.2	44.4	9.2	29.6	.06	.632
15-5-3-2-1	265 C	N	341.7	30.4	343.7	16.1	.06	.579
15-5-3-2-1	388 C	N	9.5	45.0	7.7	30.2	.03	.351
15-5-3-2-2	NRM-1	N	7.3	35.3	6.4	20.4	NA	6.335
15-5-3-2-2	NRM-2	N	7.2	34.8	6.3	19.9	1.00	6.524
15-5-3-2-2	268 C	N	8.4	30.7	7.5	15.8	.86	5.622
15-5-3-2-2	400 C	N	23.7	34.0	20.8	20.1	.65	4.252
15-5-3-2-2	530 C	N	17.3	27.9	15.7	13.5	.55	3.572
15-5-3-2-2	600 C	N	6.9	24.0	6.4	9.1	.37	2.427

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-3-3-2	NRM	N	6.0	37.5	5.2	22.6	NA	6.617
15-5-3-3-2	NRMH	N	6.5	35.1	5.7	20.2	1.00	7.130
15-5-3-3-2	5 DAYS	M	49.3	39.7	41.9	29.1	.78	6.902
15-5-3-3-2	10 DAYS	M	100.3	35.6	89.3	36.9	.38	6.493
15-5-3-3-2	20 DAYS	M	316.4	-2.2	314.9	-13.0	.37	3.863
15-5-3-3-2	30 DAYS	N	.2	56.7	.2	41.7	.06	.597
15-5-3-3-2	40 DAYS	N	5.4	56.5	4.0	41.5	.06	.644
15-5-3-3-2	265 C	N	3.3	60.9	2.3	45.9	.04	.471
15-5-3-3-2	388 C	N	23.4	61.0	16.3	46.9	.03	.330
15-5-3-3-1	NRM-1	N	13.5	40.7	11.4	26.0	NA	6.222
15-5-3-3-1	NRM-2	N	43.9	45.9	35.8	34.3	1.00	6.257
15-5-3-3-1	268 C	N	16.3	38.5	13.9	24.0	.83	5.231
15-5-3-3-1	400 C	N	16.3	35.4	14.2	21.0	.70	4.419
15-5-3-3-1	530 C	N	8.7	35.6	7.6	20.8	.47	2.971
15-5-3-3-1	600 C	N	14.1	32.5	12.4	17.9	.41	2.589

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-3-4-2	NRM	N	19.5	16.5	18.7	2.3	NA	7.140
15-5-3-4-2	NRMH	N	13.9	14.6	13.5	.1	1.00	7.700
15-5-3-4-2	5 DAYS	N	16.5	11.9	16.2	-2.5	.70	6.614
15-5-3-4-2	10 DAYS	N	11.3	19.2	10.7	4.5	.29	2.890
15-5-3-4-2	20 DAYS	N	6.2	27.3	5.7	12.4	.10	1.091
15-5-3-4-2	30 DAYS	N	1.4	37.7	1.2	22.7	.06	.641
15-5-3-4-2	40 DAYS	N	359.2	43.3	359.3	28.4	.06	.699
15-5-3-4-2	265 C	N	4.7	44.4	3.8	29.4	.05	.606
15-5-3-4-2	388 C	N	26.2	52.9	20.1	39.1	.03	.367
15-5-3-4-1	NRM-1	N	15.5	24.4	14.3	9.9	NA	6.639
15-5-3-4-1	NRM-2	N	345.7	12.6	346.0	-2.0	1.00	8.328
15-5-3-4-1	268 C	N	17.7	17.3	16.9	3.0	.65	5.412
15-5-3-4-1	400 C	N	17.1	17.8	16.3	3.4	.60	5.004
15-5-3-4-1	530 C	N	14.5	16.6	13.9	2.0	.41	3.452
15-5-3-4-1	600 C	N	18.9	11.3	18.5	-2.9	.38	3.225

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-4-1-1	NRM	N	7.4	16.3	7.1	1.4	NA	24.972
15-5-4-1-1	NRMH	N	6.3	16.7	6.0	1.8	1.00	21.457
15-5-4-1-2	NRM-1	N	4.2	13.0	4.1	-2.0	NA	22.248
15-5-4-1-2	NRM-2	N	4.0	14.0	3.8	-1.0	1.00	23.093
15-5-4-1-2	268 C	N	6.0	11.8	5.9	-3.1	.98	22.688
15-5-4-1-2	400 C	N	5.7	13.3	5.5	-1.7	.94	21.707
15-5-4-1-2	530 C	N	5.8	12.4	5.7	-2.5	.89	20.665
15-5-4-1-2	600 C	N	4.5	13.2	4.4	-1.8	.87	20.126

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-4-2-2	NRM	N	7.5	7.9	7.5	-7.0	NA	20.313
15-5-4-2-2	NRMH	N	7.0	10.7	6.9	-4.2	1.00	19.046
15-5-4-2-2	5 DAYS	N	9.4	5.9	9.4	-8.9	.80	25.312
15-5-4-2-1	NRM-1	N	7.0	13.5	6.8	-1.4	NA	21.506
15-5-4-2-1	NRM-2	N	6.7	12.7	6.5	-2.2	1.00	20.818
15-5-4-2-1	268 C	N	6.5	12.8	6.4	-2.2	.98	20.523
15-5-4-2-1	400 C	N	14.3	9.5	14.1	-5.0	.90	18.852
15-5-4-2-1	530 C	N	7.7	9.7	7.6	-5.1	.89	18.608
15-5-4-2-1	600 C	N	7.8	8.5	7.7	-6.3	.86	18.020

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-4-3-2	NRM	N	5.4	14.0	5.2	-.9	NA	21.279
15-5-4-3-2	NRMH	N	4.8	15.5	4.6	.6	1.00	21.336
15-5-4-3-2	5 DAYS	N	4.2	13.0	4.0	-1.9	.79	28.105
15-5-4-3-1	NRM-1	N	5.8	13.6	5.6	-1.3	NA	20.002
15-5-4-3-1	NRM-2	N	10.3	12.7	10.0	-2.0	1.00	19.615
15-5-4-3-1	268 C	N	6.5	11.1	6.4	-3.8	1.03	20.208
15-5-4-3-1	400 C	N	6.5	10.9	6.4	-4.0	.98	19.343
15-5-4-3-1	530 C	N	7.2	5.9	7.3	-9.0	.94	18.428
15-5-4-3-1	600 C	N	6.1	10.4	6.1	-4.6	.91	17.962

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
15-5-4-4-1	NRM	N	5.9	6.4	6.0	-8.5	NA	14.749
15-5-4-4-1	NRMH	N	19.0	8.5	18.9	-5.7	1.00	13.809
15-5-4-4-2	NRM-1	N	4.7	4.1	4.8	-10.8	NA	15.068
15-5-4-4-2	NRM-2	N	2.8	8.0	2.8	-7.0	1.00	15.529
15-5-4-4-2	268 C	N	3.0	6.2	3.0	-8.8	.98	15.235
15-5-4-4-2	400 C	N	3.4	5.5	3.5	-9.4	.92	14.385
15-5-4-4-2	530 C	N	3.0	6.2	3.0	-8.8	.87	13.526
15-5-4-4-2	600 C	N	357.9	6.0	357.8	-9.0	.76	11.846

APPENDIX 4

NON-RED BEDS

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-10P-1	7.7	67.8	355.9	59.5	50.51	2.18
5-E-10-1	7.4	68.7	355.3	60.3	39.00	1.94
5-E-9-1	344.3	73.7	337.3	64.3	34.12	1.48
5-E-8-1	330.4	60.5	328.6	51.2	55.14	2.04
5-E-7-1	318.9	74.0	320.5	64.6	37.63	1.54
5-E-6-1	316.7	70.0	318.4	60.8	46.94	1.63
5-E-5-1	5.2	3.0	5.2	-4.8	13.26	.52
5-E-4-1	42.6	65.2	23.2	60.3	31.42	1.20
5-E-3-1	51.5	74.9	19.3	70.5	15.05	.59

DEMAGNETIZATION LEVEL = 407 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-10P-1	330.2	66.2	328.3	56.8	15.51	.68
5-E-10-1	322.3	71.0	322.5	61.6	10.10	.51
5-E-9-1	216.8	25.3	220.0	27.4	16.61	.73
5-E-8-1	303.8	69.1	308.7	60.3	17.82	.66
5-E-7-1	253.3	70.6	272.3	65.8	8.66	.36
5-E-6-1	27.4	-10.5	28.5	-14.7	23.90	.83
5-E-5-1	47.1	-6.0	46.0	-7.2	19.20	.76
5-E-4-1	196.6	36.1	202.7	41.4	7.22	.28
5-E-3-1	196.6	21.7	199.9	27.4	6.80	.27

NON-RED BEDS

DEMAGNETIZATION LEVEL = 555 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-10P-1	303.1	65.3	307.1	56.7	10.77	.47
5-E-10-1	141.4	21.5	139.1	32.4	19.07	.96
5-E-9-1	248.3	36.1	251.4	32.9	12.17	.53
5-E-8-1	305.2	60.5	307.8	51.9	12.03	.45
5-E-7-1	342.4	75.3	335.6	65.8	7.55	.31
5-E-6-1	120.6	39.3	112.3	49.0	5.81	.20
5-E-5-1	99.4	4.6	94.2	11.5	12.31	.49
5-E-4-1	334.2	47.9	332.3	38.6	9.13	.35
5-E-3-1	84.7	63.2	60.3	65.7	3.27	.13

DEMAGNETIZATION LEVEL = 604 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-10P-1	91.6	9.5	85.6	15.1	5.68	.25
5-E-10-1	201.2	23.9	204.8	28.7	4.82	.24
5-E-9-1	70.2	49.9	54.8	50.2	11.32	.50
5-E-8-1	354.1	.8	354.3	-8.0	7.53	.28
5-E-7-1	113.3	10.7	108.0	19.5	6.04	.25
5-E-6-1	52.2	-3.2	50.3	-3.7	28.77	1.01
5-E-5-1	6.0	-44.0	13.4	-51.0	221.34	8.78
5-E-4-1	60.4	7.0	56.1	7.4	132.62	5.12
5-E-3-1	106.4	13.3	100.3	21.2	20.99	.84

RED BEDS

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-2-1	147.6	.8	146.4	11.2	188.39	7.73
5-E-1-1	4.9	59.2	356.7	50.9	149.21	8.13
5-D-10-1	231.6	17.4	232.2	17.4	295.46	11.38
5-D-9-1	7.7	52.1	.8	44.0	286.12	10.51
5-D-8-1	54.2	46.8	41.7	44.4	57.11	2.06
5-D-7-1	309.7	71.2	313.5	62.1	94.21	3.25
5-D-6-1	9.5	55.2	1.5	47.2	122.53	4.74
5-D-5-1	311.4	77.0	316.3	67.7	80.42	2.85
5-D-4-1	190.0	-14.2	188.6	-6.8	109.93	3.82
5-D-3-1	160.5	-37.6	158.5	-28.3	52.33	1.77
5-D-1-1	358.3	64.9	350.0	56.1	46.30	1.50
5-C-10-1	246.0	7.6	243.7	5.6	186.01	6.23
5-C-9-1	343.7	45.7	340.9	36.6	91.87	3.03
5-C-8-2	169.1	-8.1	168.7	1.1	460.86	17.34
5-C-8-1	167.5	-5.5	167.2	3.8	418.63	17.87
5-C-7-1	192.0	19.5	194.9	25.9	133.10	4.73
5-C-6-1	354.0	71.8	344.5	62.7	46.83	1.78
5-C-5-1	17.2	45.0	10.4	37.8	65.46	2.53

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-C-4-1	269.9	-45.6	255.7	-50.0	318.67	14.83
5-C-3-2	43.1	60.2	26.6	55.6	65.18	2.40
5-C-2-1	195.9	-11.3	194.6	-4.7	509.69	18.61
5-C-1-1	200.2	-4.9	199.5	1.0	218.48	8.17
5-B-10-1	174.1	-8.0	173.8	.9	213.69	9.75
5-B-9P-1	195.7	-1.5	195.6	4.9	136.90	5.21
5-B-9-1	197.0	-8.1	196.0	-1.8	843.65	32.35
5-B-8-1	185.4	3.6	186.2	11.2	188.60	6.68
5-B-7-1	307.5	53.7	308.7	45.1	49.64	1.85
5-B-6-1	15.2	56.5	5.8	48.9	39.82	1.44
5-B-5-1	297.8	50.4	299.6	42.2	27.59	1.05
5-B-4-1	178.1	-.4	178.4	8.1	213.77	8.36
5-B-3-1	173.9	-7.3	173.6	1.5	225.90	8.11
5-B-2-1	169.1	5.0	169.6	14.4	240.21	9.01
5-B-1-1	310.3	42.4	310.1	33.6	24.79	.92
5-A-10-1	16.0	28.7	12.2	21.6	76.99	2.97
5-A-9-1	197.2	-10.3	195.9	-3.9	143.95	4.96
5-A-8-1	186.3	-6.7	185.9	1.0	66.38	4.24

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-A-7-1	173.0	20.1	175.1	29.2	67.42	2.66
5-A-6-1	103.7	78.7	40.3	81.7	41.55	1.68
5-A-5-1	16.3	51.0	8.2	43.6	39.42	2.34
5-A-4-1	.2	52.4	354.4	43.8	90.77	3.34
5-A-3-1	9.9	20.8	7.7	13.3	74.71	2.89
5-A-2-1	183.0	-6.6	182.7	1.4	401.14	15.72
5-A-1-1	305.4	86.4	319.9	76.7	34.34	1.37
5-A-0-1	169.1	11.6	170.1	21.0	247.38	9.06
5-AA-9-1	192.8	-11.9	191.5	-4.9	194.67	8.09
5-AA-8-1	232.2	45.5	239.5	44.5	37.09	1.61
5-AA-7-1	196.2	-14.0	194.4	-7.3	563.12	23.11
5-AA-6-1	194.4	1.2	194.8	7.7	129.78	5.15
5-AA-5-1	118.5	59.4	102.7	68.3	45.38	1.86
5-AA-4-1	192.8	-17.7	190.8	-10.6	644.87	35.39
5-AA-3-1	66.6	20.5	59.5	21.4	84.71	4.03
5-AA-2-1	167.0	26.0	169.0	35.8	60.21	2.49
5-AA-1-1	35.2	45.1	25.8	39.9	54.66	2.47
5-AAA-9-1	190.5	-5.1	190.2	2.0	327.77	15.34

DEMAGNETIZATION LEVEL = 407 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-2-1	178.8	-19.4	177.4	-10.9	342.56	14.15
5-E-1-1	36.4	56.6	22.9	51.2	62.87	3.45
5-D-10-1	214.0	-18.0	210.3	-13.6	302.07	12.06
5-D-9-1	21.8	49.7	13.2	42.8	157.59	5.82
5-D-8-1	109.6	54.8	93.8	62.6	14.04	.51
5-D-7-1	238.4	61.3	252.6	59.0	30.67	1.06
5-D-6-1	11.2	46.9	4.8	39.1	63.90	2.48
5-D-5-1	204.7	64.7	225.1	67.8	21.34	.76
5-D-4-1	184.3	-29.0	181.5	-20.9	157.60	5.49
5-D-3-1	184.5	-29.1	181.6	-21.0	87.69	2.98
5-D-1-1	336.8	57.6	334.0	48.4	18.83	.61
5-C-10-1	242.3	-.9	238.9	-1.9	174.74	5.88
5-C-9-1	343.4	33.6	341.5	24.4	55.15	1.82
5-C-8-2	173.2	-12.0	172.5	-3.1	482.52	18.20
5-C-8-1	169.5	-6.0	169.3	3.2	434.86	18.60
5-C-7-1	195.2	3.8	195.8	10.1	120.83	4.30
5-C-6-1	33.5	55.3	21.1	49.6	20.74	.79
5-C-5-1	24.8	46.6	16.5	40.1	23.53	.91

DEMAGNETIZATION LEVEL = 407 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-C-4-1	266.2	-49.5	250.4	-53.1	395.21	18.45
5-C-3-1	60.0	58.4	41.6	56.5	43.09	1.59
5-C-2-1	196.5	-13.3	194.9	-6.7	514.83	18.87
5-C-1-1	198.1	-9.1	196.9	-2.8	216.00	8.11
5-B-10-1	172.7	-10.1	172.2	-1.2	223.77	10.23
5-B-9P-1	192.9	-8.8	192.0	-1.9	144.45	5.53
5-B-9-1	197.7	-10.4	196.3	-4.0	840.41	32.39
5-B-8-1	184.6	-4.2	184.5	3.6	192.90	6.84
5-B-7-1	295.7	31.3	295.0	23.1	25.87	.97
5-B-6-1	66.3	18.4	59.5	19.3	22.14	.80
5-B-5-1	87.9	25.9	78.9	30.5	10.80	.41
5-B-4-1	176.0	-3.6	176.0	5.1	226.59	8.89
5-B-3-1	169.6	-11.9	168.9	-2.7	230.36	8.30
5-B-2-1	166.1	-1.7	166.0	7.8	250.89	9.44
5-B-1-1	265.0	-41.1	252.2	-44.7	11.89	.44
5-A-10-1	14.9	19.8	12.5	12.8	66.88	2.59
5-A-9-1	198.3	-16.8	196.1	-10.3	140.79	4.86
5-A-8-1	182.6	-21.4	180.8	-13.2	75.45	4.85

DEMAGNETIZATION LEVEL = 407 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-A-7-1	171.1	5.7	171.8	14.9	68.38	2.71
5-A-6-1	183.8	38.9	189.8	46.4	147.44	5.97
5-A-5-1	30.6	25.5	25.9	20.3	27.34	1.63
5-A-4-1	8.6	38.2	4.2	30.3	49.19	1.82
5-A-3-1	11.5	10.6	10.5	3.5	61.53	2.39
5-A-2-1	181.0	-9.9	180.4	-1.7	391.75	15.39
5-A-1-1	116.4	45.8	105.7	54.9	13.57	.54
5-A-0-1	165.6	9.9	166.2	19.6	236.47	8.71
5-AA-9-1	192.2	-14.4	190.6	-7.2	191.56	8.00
5-AA-8-1	166.7	28.7	169.0	38.5	18.41	.80
5-AA-7-1	194.3	-15.8	192.5	-8.9	601.38	24.75
5-AA-6-1	196.7	-13.5	195.0	-6.9	105.42	4.19
5-AA-5-1	113.5	42.9	102.9	51.6	34.39	1.42
5-AA-4-1	192.1	-14.8	190.5	-7.6	644.73	35.59
5-AA-3-1	69.1	4.5	64.6	6.5	86.85	4.14
5-AA-2-1	163.5	14.6	164.2	24.5	62.10	2.57
5-AA-1-1	50.5	41.2	40.1	38.4	25.26	1.15
5-AAA-9-1	189.0	-8.3	188.3	-1.0	369.53	17.38

DEMAGNETIZATION LEVEL = 555 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-2-1	177.5	-24.3	175.6	-15.7	221.42	9.17
5-E-1-1	212.9	38.5	219.4	40.9	26.94	1.48
5-D-10-1	216.8	-20.5	212.3	-16.4	175.11	6.80
5-D-9-1	14.0	57.1	4.7	49.4	128.18	4.75
5-D-8-1	161.0	13.1	161.4	23.2	14.90	.54
5-D-7-1	233.2	34.9	237.3	34.0	31.63	1.10
5-D-6-1	12.3	54.8	3.9	47.0	51.71	2.01
5-D-5-1	185.0	36.6	190.6	43.9	21.66	.77
5-D-4-1	182.9	-26.8	180.4	-18.6	166.58	5.81
5-D-3-1	185.4	-22.2	183.4	-14.3	95.71	3.26
5-D-1-1	289.5	66.4	296.8	58.5	9.56	.31
5-C-10-1	242.1	-1.8	238.5	-2.7	181.53	6.12
5-C-9-1	327.8	37.8	326.5	28.5	41.38	1.37
5-C-8-1	170.1	-11.8	169.5	-2.7	431.30	18.48
5-C-8-2	167.6	-10.9	167.0	-1.6	459.84	17.37
5-C-7-1	198.2	-1.6	198.0	4.5	129.87	4.63
5-C-6-1	196.6	55.4	209.6	60.4	9.16	.35
5-C-5-1	134.2	60.1	125.3	70.6	6.38	.25

DEMAGNETIZATION LEVEL = 555 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-C-4-1	268.6	-49.3	252.9	-53.4	361.02	16.89
5-C-3-1	99.9	77.2	45.6	80.2	30.10	1.11
5-C-2-1	196.0	-12.9	194.5	-6.2	504.24	18.52
5-C-1-1	198.6	-12.5	196.9	-6.2	222.90	8.39
5-B-10-1	173.5	-13.0	172.8	-4.2	201.13	9.22
5-B-9P-1	194.0	-10.4	192.8	-3.6	137.86	5.30
N-B-9-1	195.6	-8.6	194.6	-2.1	832.82	32.20
5-B-8-1	178.6	-6.0	178.4	2.5	180.85	6.43
5-B-7-1	258.1	18.2	256.9	14.0	30.55	1.15
5-B-6-1	95.8	2.6	90.8	9.0	17.43	.63
5-B-5-1	227.4	11.6	227.3	12.5	15.26	.59
5-B-4-1	177.6	-5.1	177.5	3.4	226.98	8.92
5-B-3-1	169.2	-14.4	168.4	-5.2	229.34	8.28
5-B-2-1	166.6	-1.9	166.5	7.6	247.34	9.32
5-B-1-1	215.4	-53.4	203.4	-48.0	16.16	.60
5-A-10-1	15.7	19.2	13.3	12.4	56.11	2.17
5-A-9-1	194.2	-19.3	191.9	-12.3	140.60	4.86
5-A-8-1	183.7	-24.3	181.5	-16.2	77.49	4.99

DEMAGNETIZATION LEVEL = 555 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-A-7-1	172.2	3.0	172.7	12.1	64.91	2.57
5-A-6-1	178.7	17.5	180.9	25.8	22.71	.92
5-A-5-1	49.0	5.2	46.0	3.8	21.30	1.27
5-A-4-1	8.7	25.0	6.0	17.3	31.31	1.16
5-A-3-1	13.7	3.2	13.5	-3.5	54.66	2.12
5-A-2-1	179.0	-8.3	178.6	.1	380.12	14.95
5-A-1-1	144.6	17.8	143.0	28.6	8.94	.36
5-A-0-1	164.2	8.3	164.6	18.1	233.81	8.65
5-AA-9-1	190.7	-13.7	189.3	-6.5	177.05	7.41
5-AA-8-1	171.3	18.4	173.1	27.6	20.66	.94
5-AA-7-1	193.9	-17.7	191.8	-10.7	582.60	24.00
5-AA-6-1	194.6	-13.6	193.0	-6.8	101.27	4.03
5-AA-5-1	120.7	36.2	113.1	46.0	30.59	1.26
5-AA-4-1	191.7	-16.5	189.9	-9.3	606.46	33.56
5-AA-3-1	69.5	1.7	65.4	3.9	83.86	4.00
5-AA-2-1	170.7	7.7	171.5	17.0	77.44	3.21
5-AA-1-1	160.0	-9.7	159.3	.0	18.79	.86
5-AAA-9-1	189.1	-11.3	188.1	-3.9	354.27	16.70

DEMAGNETIZATION LEVEL = 604 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-E-2-1	167.8	-7.8	167.4	1.5	222.83	9.28
5-E-1-1	178.9	29.0	182.7	37.3	19.82	1.09
5-D-10-1	204.8	-21.6	201.3	-15.8	163.29	6.36
5-D-9-1	195.8	12.6	197.7	18.6	81.47	3.03
5-D-8-1	113.5	7.9	108.6	16.7	16.81	.61
5-D-7-1	185.6	.7	186.1	8.4	19.10	.66
5-D-6-1	215.5	15.6	217.0	18.3	28.62	1.12
5-D-5-1	186.1	11.0	187.7	18.5	37.57	1.35
5-D-4-1	185.0	-26.1	182.5	-18.1	165.11	5.77
5-D-3-1	189.5	-22.6	187.1	-15.0	106.76	3.64
5-D-1-1	163.5	35.0	165.9	45.1	16.93	.55
5-C-10-1	239.8	-7.0	235.6	-7.3	180.62	6.10
5-C-9-1	319.5	23.3	318.2	13.8	17.54	.58
5-C-6-1	201.2	-8.3	199.9	-2.5	24.49	.93
5-C-5-1	105.5	2.9	100.7	10.6	15.61	.61
5-C-4-1	263.6	-51.0	247.1	-54.0	344.74	16.13

DEMAGNETIZATION LEVEL = 604 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
5-C-3-1	185.4	8.8	186.8	16.4	39.88	1.48
5-B-7-1	278.3	7.8	274.8	1.0	18.12	.68
5-B-6-1	190.1	31.3	195.0	37.8	14.21	.52
5-B-5-1	220.7	-5.8	218.3	-3.0	14.84	.57
5-B-1-1	91.3	-73.8	108.2	-66.9	14.58	.55
5-A-10-1	329.1	-7.1	328.0	-17.7	4.15	.16
5-A-7-1	173.3	5.3	174.0	14.3	66.52	2.64
5-A-6-1	185.5	7.7	186.8	15.2	28.56	1.16
5-A-5-1	104.6	-47.6	107.2	-40.3	7.39	.44
5-A-4-1	305.5	38.6	305.2	30.0	11.12	.41
5-A-3-1	13.5	-13.0	15.4	-19.3	32.09	1.25
5-A-1-1	190.0	8.6	191.4	15.5	15.63	.63
5-A-C-1	169.6	9.0	170.5	18.4	151.85	5.64
5-AA-8-1	185.4	5.6	186.4	13.2	30.05	1.38
5-AA-5-1	169.6	-2.6	169.6	6.6	43.30	1.79
5-AA-2-1	181.4	-3.0	181.5	5.2	102.72	4.27

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
6-A-10	155.9	69.7	155.4	76.9	55.68	2.27
6-A-8	195.3	10.7	196.3	15.9	52.45	2.69
6-A-6	345.8	54.6	344.3	47.9	27.73	1.56
6-A-4	18.2	52.4	12.9	46.7	31.87	1.68

DEMAGNETIZATION LEVEL = 423 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
6-A-10	179.8	28.2	181.6	34.6	56.33	2.31
6-A-8	186.1	-7.1	185.8	-1.0	72.83	3.79
6-A-6	44.7	49.8	36.8	46.4	11.25	.64
6-A-4	339.9	68.6	338.8	61.8	11.12	.59

DEMAGNETIZATION LEVEL = 560 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
6-A-10	178.6	5.3	179.1	11.8	65.55	2.69
6-A-8	189.3	-7.9	188.9	-2.0	74.94	3.90
6-A-6	98.4	14.6	95.0	18.3	5.87	.33
6-A-4	123.0	77.4	91.7	82.3	6.67	.35

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
9-10	202.7	2.7	202.5	6.6	409.35	16.61
9-9	203.9	46.4	211.5	48.9	42.60	1.53
9-8P	137.2	50.5	132.6	60.6	90.46	3.16
9-8	19.5	65.2	6.5	59.0	120.18	3.98
9-7	102.0	66.4	78.0	71.8	46.93	1.69
9-6	12.0	82.2	346.2	74.9	34.83	1.26
9-5	62.9	36.3	52.5	36.0	25.78	2.03
9-4-2	191.3	55.5	202.1	60.0	25.92	1.30
9-4-1	16.1	58.9	6.3	52.7	60.73	2.30
9-3-2	17.8	47.0	10.8	41.0	58.48	3.16
9-3-1	15.0	46.5	8.6	40.3	90.18	3.38
9-2	358.9	64.9	350.4	57.7	51.95	2.05
9-1-2	21.5	31.3	17.0	25.9	173.24	8.33
9-1-1	16.6	29.2	12.8	23.4	192.86	7.48

DEMAGNETIZATION LEVEL = 420 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
9-10	202.0	-1.1	201.4	3.1	471.26	19.10
9-9	176.8	13.3	178.3	20.4	36.09	1.30
9-8P	131.4	46.5	125.2	56.3	53.54	1.88
9-8	11.9	62.4	1.6	55.8	74.42	2.47
9-7	149.9	44.1	149.7	54.0	30.05	1.08
9-6	214.8	59.1	227.0	59.7	13.00	.47
9-5	159.8	13.8	159.9	22.6	13.13	1.03
9-4-2	191.2	26.2	194.6	31.2	18.89	.95
9-4-1	23.1	55.9	13.0	50.2	38.48	1.46
9-3-2	16.6	41.0	10.9	35.0	41.74	2.21
9-3-1	20.1	42.8	13.7	37.0	70.25	2.64
9-2	20.8	61.9	9.0	56.0	26.94	1.07
9-1-2	21.1	27.4	17.2	22.1	147.76	7.14
9-1-1	17.9	27.2	14.3	21.6	157.96	6.15

DEMAGNETIZATION LEVEL = 550 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
9-10	201.7	-1.3	201.1	2.9	447.31	18.15
9-9	181.9	1.9	182.4	8.5	317.98	11.44
9-8P	123.0	48.7	113.8	57.8	44.93	1.58
9-8	347.6	65.3	341.3	57.8	61.37	2.04
9-7	172.4	25.6	174.8	33.3	34.32	1.24
9-6	210.8	20.4	212.5	22.4	11.98	.43
9-5	162.5	-6.4	161.8	1.7	103.45	8.15
9-4-2	198.8	27.0	202.2	30.7	21.88	1.10
9-4-1	33.7	65.2	17.4	60.3	23.13	.88
9-3-2	19.8	45.3	12.9	39.5	29.72	1.61
9-3-1	16.2	50.9	8.6	44.7	48.31	1.81
9-2	61.7	65.9	39.3	64.6	25.19	1.00
9-1-2	28.3	31.5	23.0	26.8	95.61	4.63
9-1-1	18.5	28.5	14.7	22.9	99.61	3.89

APPENDIX 5

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-E-10P-1	NRM	N	7.7	67.8	355.9	59.5	1.00	2.177
5-E-10P-1	407	N	330.2	66.2	328.3	56.8	.31	.678
5-E-10P-1	555	M	303.1	65.3	307.1	56.7	.21	.473
5-E-10P-1	604	M	91.6	9.5	85.6	15.1	.11	.250
5-E-10-1	NRM	N	7.4	68.7	355.3	60.3	1.00	1.937
5-E-10-1	407	N	322.3	71.0	322.5	61.6	.26	.508
5-E-10-1	555	M	141.4	21.5	139.1	32.4	.49	.964
5-E-10-1	604	M	201.2	23.9	204.8	28.7	.12	.244
5-E-9-1	NRM	N	344.3	73.7	337.3	64.3	1.00	1.479
5-E-9-1	407	M	216.8	25.3	220.0	27.4	.49	.727
5-E-9-1	555	M	248.3	36.1	251.4	32.9	.36	.534
5-E-9-1	604	M	70.2	49.9	54.8	50.2	.33	.498
5-E-8-1	NRM	N	330.4	60.5	328.6	51.2	1.00	2.039
5-E-8-1	407	M	303.8	69.1	308.7	60.3	.32	.665
5-E-8-1	555	M	305.2	60.5	307.8	51.9	.22	.450
5-E-8-1	604	N	354.1	.8	354.3	-8.0	.14	.282

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-E-7-1	NRM	N	318.9	74.0	320.5	64.6	1.00	1.545
5-E-7-1	407	M	253.3	70.6	272.3	65.8	.23	.358
5-E-7-1	555	N	342.4	75.3	335.6	65.8	.20	.313
5-E-7-1	604	M	113.3	10.7	108.0	19.5	.16	.251
5-E-6-1	NRM	N	316.7	70.0	318.4	60.8	1.00	1.627
5-E-6-1	407	M	27.4	-10.5	28.5	-14.7	.51	.830
5-E-6-1	555	M	120.6	39.3	112.3	49.0	.12	.202
5-E-6-1	604	M	52.2	-3.2	50.3	-3.7	.61	1.005
5-E-5-1	NRM	N	5.2	3.0	5.2	-4.8	1.00	.522
5-E-5-1	407	M	47.1	-6.0	46.0	-7.2	1.45	.758
5-E-5-1	555	M	99.4	4.6	94.2	11.5	.93	.486
5-E-5-1	604	M	6.0	-44.0	13.4	-51.0	16.69	8.782
5-E-4-1	NRM	N	42.6	65.2	23.2	60.3	1.00	1.199
5-E-4-1	407	M	196.6	36.1	202.7	41.4	.23	.276
5-E-4-1	555	N	334.2	47.9	332.3	38.6	.29	.349
5-E-4-1	604	M	60.4	7.0	56.1	7.4	4.22	5.119

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-E-3-1	NRM	M	51.5	74.9	19.3	70.5	1.00	.593
5-E-3-1	407	M	196.6	21.7	199.9	27.4	.45	.269
5-E-3-1	555	M	84.7	63.2	60.3	65.7	.22	.130
5-E-3-1	604	M	106.4	13.3	100.3	21.2	1.39	.839
5-E-2-1	NRM	M	147.6	.8	146.4	11.2	1.00	7.735
5-E-2-1	407	R	178.8	-19.4	177.4	-10.9	1.82	14.152
5-E-2-1	555	R	177.5	-24.3	175.6	-15.7	1.18	9.174
5-E-2-1	604	R	167.8	-7.8	167.4	1.5	1.18	9.280
5-E-1-1	NRM	N	4.9	59.2	356.7	50.9	1.00	8.128
5-E-1-1	407	N	36.4	56.6	22.9	51.2	.42	3.446
5-E-1-1	555	M	212.9	38.5	219.4	40.9	.18	1.480
5-E-1-1	604	M	178.9	29.0	182.7	37.3	.13	1.092
5-D-10-1	NRM	M	231.6	17.4	232.2	17.4	1.00	11.378
5-D-10-1	407	R	214.0	-18.0	210.3	-13.6	1.02	12.056
5-D-10-1	555	R	216.8	-20.5	212.3	-16.4	.59	6.798
5-D-10-1	604	R	204.8	-21.6	201.3	-15.8	.55	6.359

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-D-9-1	NRM	N	7.7	52.1	.8	44.0	1.00	10.507
5-D-9-1	407	N	21.8	49.7	13.2	42.8	.55	5.824
5-D-9-1	555	N	14.0	57.1	4.7	49.4	.45	4.753
5-D-9-1	604	M	195.8	12.6	197.7	18.6	.28	3.029
5-D-8-1	NRM	M	54.2	46.8	41.7	44.4	1.00	2.060
5-D-8-1	407	M	109.6	54.8	93.8	62.6	.25	.507
5-D-8-1	555	M	161.0	13.1	161.4	23.2	.26	.539
5-D-8-1	604	M	113.5	7.9	108.6	16.7	.29	.609
5-D-7-1	NRM	M	309.7	71.2	313.5	62.1	1.00	3.246
5-D-7-1	407	M	238.4	61.3	252.6	59.0	.33	1.061
5-D-7-1	555	M	233.2	34.9	237.3	34.0	.34	1.096
5-D-7-1	604	M	185.6	.7	186.1	8.4	.20	.665
5-D-6-1	NRM	N	9.5	55.2	1.5	47.2	1.00	4.743
5-D-6-1	407	N	11.2	46.9	4.8	39.1	.52	2.482
5-D-6-1	555	N	12.3	54.8	3.9	47.0	.42	2.012
5-D-6-1	604	M	215.5	15.6	217.0	18.3	.23	1.117

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-D-5-1	NRM	M	311.4	77.0	316.3	67.7	1.00	2.855
5-D-5-1	407	M	204.7	64.7	225.1	67.8	.27	.761
5-D-5-1	555	M	185.0	36.6	190.6	43.9	.27	.774
5-D-5-1	604	M	186.1	11.0	187.7	18.5	.47	1.346
5-D-4-1	NRM	R	190.0	-14.2	188.6	-6.8	1.00	3.817
5-D-4-1	407	R	184.3	-29.0	181.5	-20.9	1.43	5.492
5-D-4-1	555	R	182.9	-26.8	180.4	-18.6	1.52	5.813
5-D-4-1	604	R	185.0	-26.1	182.5	-18.1	1.50	5.773
5-D-3-1	NRM	R	160.5	-37.6	158.5	-28.3	1.00	1.773
5-D-3-1	407	R	184.5	-29.1	181.6	-21.0	1.68	2.981
5-D-3-1	555	R	185.4	-22.2	183.4	-14.3	1.83	3.258
5-D-3-1	604	R	189.5	-22.6	187.1	-15.0	2.04	3.641
5-D-1-1	NRM	N	358.3	64.9	350.0	56.1	1.00	1.502
5-D-1-1	407	N	336.8	57.6	334.0	48.4	.41	.613
5-D-1-1	555	M	289.5	66.4	296.8	58.5	.21	.312
5-D-1-1	604	M	163.5	35.0	165.9	45.1	.37	.553

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-C-10-1	NRM	M	246.0	7.6	243.7	5.6	1.00	6.234
5-C-10-1	407	M	242.3	-.9	238.9	-1.9	.94	5.875
5-C-10-1	555	M	242.1	-1.8	238.5	-2.7	.98	6.120
5-C-10-1	610	M	239.8	-7.0	235.6	-7.3	.97	6.102
5-C-9-1	NRM	N	343.7	45.7	340.9	36.6	1.00	3.029
5-C-9-1	407	N	343.4	33.6	341.5	24.4	.60	1.823
5-C-9-1	555	N	327.8	37.8	326.5	28.5	.45	1.371
5-C-9-1	610	N	319.5	23.3	318.2	13.8	.19	.581
5-C-8-2	NRM	R	169.1	-8.1	168.7	1.1	1.00	17.342
5-C-8-2	407	R	173.2	-12.0	172.5	-3.1	1.05	18.199
5-C-8-2	555	R	167.6	-10.9	167.0	-1.6	1.00	17.373
5-C-8-1	NRM	R	167.5	-5.5	167.2	3.8	1.00	17.866
5-C-8-1	407	R	169.5	-6.0	169.3	3.2	1.04	18.600
5-C-8-1	555	R	170.1	-11.8	169.5	-2.7	1.03	18.479

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-C-7-1	NRM	M	192.0	19.5	194.9	25.9	1.00	4.727
5-C-7-1	407	M	195.2	3.8	195.8	10.1	.91	4.301
5-C-7-1	555	R	198.2	-1.6	198.0	4.5	.98	4.629
5-C-6-1	NRM	N	354.0	71.8	344.5	62.7	1.00	1.777
5-C-6-1	407	N	33.5	55.3	21.1	49.6	.44	.789
5-C-6-1	555	M	196.6	55.4	209.6	60.4	.20	.349
5-C-6-1	610	R	201.2	-8.3	199.9	-2.5	.52	.935
5-C-5-1	NRM	N	17.2	45.0	10.4	37.8	1.00	2.528
5-C-5-1	407	N	24.8	46.6	16.5	40.1	.36	.912
5-C-5-1	555	M	134.2	60.1	125.3	70.6	.10	.248
5-C-5-1	610	M	105.5	2.9	100.7	10.6	.24	.607
5-C-4-1	NRM	M	269.9	-45.6	255.7	-50.0	1.00	14.829
5-C-4-1	407	M	266.2	-49.5	250.4	-53.1	1.24	18.454
5-C-4-1	555	M	268.6	-49.3	252.9	-53.4	1.13	16.889
5-C-4-1	610	M	263.6	-51.0	247.1	-54.0	1.08	16.127

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-C-3-1	NRM	N	43.1	60.2	26.6	55.6	1.00	2.401
5-C-3-1	407	M	60.0	58.4	41.6	56.5	.66	1.591
5-C-3-1	555	M	99.9	77.2	45.6	80.2	.46	1.113
5-C-3-1	610	M	185.4	8.8	186.8	16.4	.61	1.477
5-C-2-1	NRM	R	195.9	-11.3	194.6	-4.7	1.00	18.607
5-C-2-1	407	R	196.5	-13.3	194.9	-6.7	1.01	18.866
5-C-2-1	555	R	196.0	-12.9	194.5	-6.2	.99	18.523
5-C-1-1	NRM	R	200.2	-4.9	199.5	1.0	1.00	8.170
5-C-1-1	407	R	198.1	-9.1	196.9	-2.8	.99	8.109
5-C-1-1	555	R	198.6	-12.5	196.9	-6.2	1.02	8.394
5-B-10-1	NRM	R	174.1	-8.0	173.8	.9	1.00	9.746
5-B-10-1	407	R	172.7	-10.1	172.2	-1.2	1.05	10.232
5-B-10-1	555	R	173.5	-13.0	172.8	-4.2	.94	9.218
5-B-9P-1	NRM	R	195.7	-1.5	195.6	4.9	1.00	5.215
5-B-9P-1	407	R	192.9	-8.8	192.0	-1.9	1.06	5.529
5-B-9P-1	555	R	194.0	-10.4	192.8	-3.6	1.01	5.296

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-B-9-1	NRM	R	197.0	-8.1	196.0	-1.8	1.00	32.355
5-B-9-1	407	R	197.7	-10.4	196.3	-4.0	1.00	32.393
5-B-9-1	555	R	195.6	-8.6	194.6	-2.1	.99	32.202
5-B-8-1	NRM	M	185.4	3.6	186.2	11.2	1.00	6.676
5-B-8-1	407	R	184.6	-4.2	184.5	3.6	1.02	6.843
5-B-8-1	555	R	178.6	-6.0	178.4	2.5	.96	6.426
5-B-7-1	NRM	M	307.5	53.7	308.7	45.1	1.00	1.848
5-B-7-1	407	M	295.7	31.3	295.0	23.1	.52	.967
5-B-7-1	555	M	258.1	18.2	256.9	14.0	.62	1.145
5-B-7-1	610	M	278.3	7.8	274.8	1.0	.36	.681
5-B-6-1	NRM	N	15.2	56.5	5.8	48.9	1.00	1.440
5-B-6-1	407	M	66.3	18.4	59.5	19.3	.56	.804
5-B-6-1	555	M	95.8	2.6	90.8	9.0	.44	.634
5-B-6-1	610	M	190.1	31.3	195.0	37.8	.36	.518

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-B-5-1	NRM	M	297.8	50.4	299.6	42.2	1.00	1.054
5-B-5-1	407	M	87.9	25.9	78.9	30.5	.39	.414
5-B-5-1	555	M	227.4	11.6	227.3	12.5	.55	.586
5-B-5-1	610	R	220.7	-5.8	218.3	-3.0	.54	.571
5-B-4-1	NRM	R	178.1	-.4	178.4	8.1	1.00	8.362
5-B-4-1	407	R	176.0	-3.6	176.0	5.1	1.06	8.887
5-B-4-1	555	R	177.6	-5.1	177.5	3.4	1.06	8.920
5-B-3-1	NRM	R	173.9	-7.3	173.6	1.5	1.00	8.110
5-B-3-1	407	R	169.6	-11.9	168.9	-2.7	1.02	8.302
5-B-3-1	555	R	169.2	-14.4	168.4	-5.2	1.02	8.284
5-B-2-1	NRM	M	169.1	5.0	169.6	14.4	1.00	9.008
5-B-2-1	407	R	166.1	-1.7	166.0	7.8	1.04	9.436
5-B-2-1	555	R	166.6	-1.9	166.5	7.6	1.03	9.322

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-B-1-1	NRM	M	310.3	42.4	310.1	33.6	1.00	.923
5-B-1-1	407	M	265.0	-41.1	252.2	-44.7	.48	.444
5-B-1-1	555	R	215.4	-53.4	203.4	-48.0	.65	.604
5-B-1-1	610	M	91.3	-73.8	108.2	-66.9	.59	.546
5-A-10-1	NRM	N	16.0	28.7	12.2	21.6	1.00	2.968
5-A-10-1	407	N	14.9	19.8	12.5	12.8	.87	2.587
5-A-10-1	555	N	15.7	19.2	13.3	12.4	.73	2.174
5-A-10-1	610	M	329.1	-7.1	328.0	-17.7	.05	.161
5-A-9-1	NRM	R	197.2	-10.3	195.9	-3.9	1.00	4.958
5-A-9-1	407	R	198.3	-16.8	196.1	-10.3	.98	4.856
5-A-9-1	555	R	194.2	-19.3	191.9	-12.3	.98	4.855
5-A-8-1	NRM	R	186.3	-6.7	185.9	1.0	1.00	4.238
5-A-8-1	407	R	182.6	-21.4	180.8	-13.2	1.14	4.847
5-A-8-1	555	R	183.7	-24.3	181.5	-16.2	1.17	4.990

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-A-7-1	NRM	M	173.0	20.1	175.1	29.2	1.00	2.664
5-A-7-1	407	M	171.1	5.7	171.8	14.9	1.01	2.705
5-A-7-1	555	M	172.2	3.0	172.7	12.1	.96	2.571
5-A-7-1	610	M	173.3	5.3	174.0	14.3	.99	2.638
5-A-6-1	NRM	M	103.7	78.7	40.3	81.7	1.00	1.677
5-A-6-1	407	M	183.8	38.9	189.8	46.4	3.55	5.973
5-A-6-1	555	M	178.7	17.5	180.9	25.8	.55	.922
5-A-6-1	610	M	185.5	7.7	186.8	15.2	.69	1.163
5-A-5-1	NRM	N	16.3	51.0	8.2	43.6	1.00	2.341
5-A-5-1	407	N	30.6	25.5	25.9	20.3	.69	1.628
5-A-5-1	555	M	49.0	5.2	46.0	3.8	.54	1.271
5-A-5-1	610	M	104.6	-47.6	107.2	-40.3	.19	.442
5-A-4-1	NRM	N	.2	52.4	354.4	43.8	1.00	3.345
5-A-4-1	407	N	8.6	38.2	4.2	30.3	.54	1.821
5-A-4-1	555	N	8.7	25.0	6.0	17.3	.34	1.162
5-A-4-1	610	M	305.5	38.6	305.2	30.0	.12	.414

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-A-3-1	NRM	N	9.9	20.8	7.7	13.3	1.00	2.894
5-A-3-1	407	N	11.5	10.6	10.5	3.5	.82	2.386
5-A-3-1	555	N	13.7	3.2	13.5	-3.5	.73	2.123
5-A-3-1	610	M	13.5	-13.0	15.4	-19.3	.43	1.249
5-A-2-1	NRM	R	183.0	-6.6	182.7	1.4	1.00	15.721
5-A-2-1	407	R	181.0	-9.9	180.4	-1.7	.98	15.386
5-A-2-1	555	R	179.0	-8.3	178.6	.1	.95	14.949
5-A-1-1	NRM	M	305.4	86.4	319.9	76.7	1.00	1.368
5-A-1-1	407	M	116.4	45.8	105.7	54.9	.40	.542
5-A-1-1	555	M	144.6	17.8	143.0	28.6	.26	.357
5-A-1-1	610	M	190.0	8.6	191.4	15.5	.46	.625
5-A-0-1	NRM	M	169.1	11.6	170.1	21.0	1.00	9.063
5-A-0-1	407	M	165.6	9.9	166.2	19.6	.96	8.712
5-A-0-1	555	M	164.2	8.3	164.6	18.1	.95	8.649
5-A-0-1	610	M	169.6	9.0	170.5	18.4	.61	5.637

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-AA-9-1	NRM	R	192.8	-11.9	191.5	-4.9	1.00	8.095
5-AA-9-1	407	R	192.2	-14.4	190.6	-7.2	.98	7.996
5-AA-9-1	555	R	190.7	-13.7	189.3	-6.5	.91	7.407
5-AA-8-1	NRM	M	232.2	45.5	239.5	44.5	1.00	1.607
5-AA-8-1	407	M	166.7	28.7	169.0	38.5	.50	.804
5-AA-8-1	555	M	171.3	18.4	173.1	27.6	.56	.942
5-AA-8-1	610	M	185.4	5.6	186.4	13.2	.81	1.375
5-AA-7-1	NRM	R	196.2	-14.0	194.4	-7.3	1.00	23.109
5-AA-7-1	407	R	194.3	-15.8	192.5	-8.9	1.07	24.746
5-AA-7-1	555	R	193.9	-17.7	191.8	-10.7	1.03	23.996
5-AA-6-1	NRM	M	194.4	1.2	194.8	7.7	1.00	5.154
5-AA-6-1	407	R	196.7	-13.5	195.0	-6.9	.81	4.192
5-AA-6-1	555	R	194.6	-13.6	193.0	-6.8	.78	4.032

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-AA-5-1	NRM	M	118.5	59.4	102.7	68.3	1.00	1.864
5-AA-5-1	407	M	113.5	42.9	102.9	51.6	.76	1.418
5-AA-5-1	555	M	120.7	36.2	113.1	46.0	.67	1.264
5-AA-5-1	610	R	169.6	-2.6	169.6	6.6	.95	1.791
5-AA-4-1	NRM	R	192.8	-17.7	190.8	-10.6	1.00	35.393
5-AA-4-1	407	R	192.1	-14.8	190.5	-7.6	1.00	35.589
5-AA-4-1	555	R	191.7	-16.5	189.9	-9.3	.94	33.564
5-AA-3-1	NRM	M	66.6	20.5	59.5	21.4	1.00	4.025
5-AA-3-1	407	M	69.1	4.5	64.6	6.5	1.03	4.137
5-AA-3-1	555	M	69.5	1.7	65.4	3.9	.99	4.003
5-AA-2-1	NRM	M	167.0	26.0	169.0	35.8	1.00	2.486
5-AA-2-1	407	M	163.5	14.6	164.2	24.5	1.03	2.573
5-AA-2-1	555	M	170.7	7.7	171.5	17.0	1.29	3.214
5-AA-2-1	610	R	181.4	-3.0	181.5	5.2	1.71	4.271

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
5-AA-1-1	NRM	N	35.2	45.1	25.8	39.9	1.00	2.473
5-AA-1-1	407	M	50.5	41.2	40.1	38.4	.46	1.149
5-AA-1-1	555	R	160.0	-9.7	159.3	.0	.34	.857
5-AAA-9-1	NRM	R	190.5	-5.1	190.2	2.0	1.00	15.343
5-AAA-9-1	407	R	189.0	-8.3	188.3	-1.0	1.13	17.378
5-AAA-9-1	555	R	189.1	-11.3	188.1	-3.9	1.08	16.704

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
6-A-10	NRM	M	155.9	69.7	155.4	76.9	1.00	2.272
6-A-10	423	M	179.8	28.2	181.6	34.6	1.01	2.307
6-A-10	560	M	178.6	5.3	179.1	11.8	1.18	2.688
6-A-8	NRM	M	195.3	10.7	196.3	15.9	1.00	2.695
6-A-8	423	R	186.1	-7.1	185.8	-1.0	1.39	3.788
6-A-8	560	R	189.3	-7.9	188.9	-2.0	1.43	3.904
6-A-6	NRM	N	345.8	54.6	344.3	47.9	1.00	1.564
6-A-6	423	N	44.7	49.8	36.8	46.4	.41	.638
6-A-6	560	M	98.4	14.6	95.0	18.3	.21	.333
6-A-4	NRM	N	18.2	52.4	12.9	46.7	1.00	1.676
6-A-4	423	N	339.9	68.6	338.8	61.8	.35	.587
6-A-4	560	M	123.0	77.4	91.7	82.3	.21	.352

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
9-10	NRM	M	202.7	2.7	202.5	6.6	1.00	16.608
9-10	420	R	202.0	-1.1	201.4	3.1	1.15	19.103
9-10	550	R	201.7	-1.3	201.1	2.9	1.09	18.148
9-9	NRM	M	203.9	46.4	211.5	48.9	1.00	1.531
9-9	420	M	176.8	13.3	178.3	20.4	.85	1.299
9-9	550	M	181.9	1.9	182.4	8.5	7.46	11.442
9-8P	NRM	M	137.2	50.5	132.6	60.6	1.00	3.158
9-8P	420	M	131.4	46.5	125.2	56.3	.59	1.876
9-8P	550	M	123.0	48.7	113.8	57.8	.50	1.576
9-8	NRM	N	19.5	65.2	6.5	59.0	1.00	3.977
9-8	420	N	11.9	62.4	1.6	55.8	.62	2.471
9-8	550	N	347.6	65.3	341.3	57.8	.51	2.039
9-7	NRM	M	102.0	66.4	78.0	71.8	1.00	1.689
9-7	420	M	149.9	44.1	149.7	54.0	.64	1.084
9-7	550	M	172.4	25.6	174.8	33.3	.73	1.239

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
9-6	NRM	N	12.0	82.2	346.2	74.9	1.00	1.255
9-6	420	M	214.8	59.1	227.0	59.7	.37	.470
9-6	550	M	210.8	20.4	212.5	22.4	.34	.434
9-5	NRM	M	62.9	36.3	52.5	36.0	1.00	2.029
9-5	420	M	159.8	13.8	159.9	22.6	.51	1.035
9-5	550	R	162.5	-6.4	161.8	1.7	4.01	8.149
9-4-1	NRM	N	15.1	58.9	6.3	52.7	1.00	2.299
9-4-1	420	N	23.1	55.9	13.0	50.2	.63	1.459
9-4-1	550	N	33.7	65.2	17.4	60.3	.38	.878
9-4-2	NRM	M	191.3	55.5	202.1	60.0	1.00	1.297
9-4-2	420	M	191.2	26.2	194.6	31.2	.73	.947
9-4-2	550	M	198.8	27.0	202.2	30.7	.84	1.098
9-3-1	NRM	N	15.0	46.5	8.6	40.3	1.00	3.376
9-3-1	420	N	20.1	42.8	13.7	37.0	.78	2.637
9-3-1	550	N	16.2	50.9	8.6	44.7	.54	1.814

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
9-3-2	NRM	N	17.8	47.0	10.8	41.0	1.00	3.155
9-3-2	420	N	16.6	41.0	10.9	35.0	.71	2.215
9-3-2	550	N	19.8	45.3	12.9	39.5	.51	1.609
9-2	NRM	N	358.9	64.9	350.4	57.7	1.00	2.050
9-2	420	N	20.8	61.9	9.0	56.0	.52	1.067
9-2	550	M	61.7	65.9	39.3	64.6	.48	1.000
9-1-1	NRM	N	16.6	29.2	12.8	23.4	1.00	7.479
9-1-1	420	N	17.9	27.2	14.3	21.6	.82	6.151
9-1-1	550	N	18.5	28.5	14.7	22.9	.52	3.887
9-1-2	NRM	N	21.5	31.3	17.0	25.9	1.00	8.330
9-1-2	420	N	21.1	27.4	17.2	22.1	.85	7.142
9-1-2	550	N	28.3	31.5	23.0	26.8	.55	4.630

APPENDIX 6

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
7-A-1	.1	33.0	353.3	13.8	88.07	3.48
7-A-1P	14.9	32.9	5.4	17.5	127.29	4.92
7-A-2-1	355.2	46.2	345.3	25.5	68.75	2.74
7-A-2-2	2.9	41.2	353.0	22.2	58.38	2.97
7-A-3	22.2	48.2	4.1	33.3	54.08	2.00
7-A-4	359.6	37.6	351.5	18.0	291.70	10.40
7-A-5	355.3	39.1	347.5	18.7	331.90	14.25
7-A-6	354.8	34.3	348.5	13.9	497.84	18.34
7-A-7	354.1	36.8	347.2	16.2	575.33	20.85
7-A-7P	358.8	38.6	350.5	18.9	599.05	21.06
7-B-2-1	8.4	36.7	358.8	19.2	118.91	4.05
7-B-2-2	9.7	41.3	358.1	23.8	106.90	4.28
7-B-4	12.4	49.8	356.4	32.3	113.26	4.07
7-B-6	9.7	40.5	358.4	23.1	139.61	4.89
7-B-8	1.2	41.9	351.4	22.5	106.30	5.01
7-B-10	73.4	67.5	12.5	63.9	43.58	1.52
7-C-2	16.3	56.3	355.5	39.1	64.36	2.65
7-C-4	8.6	47.0	354.9	28.9	122.15	4.34
7-C-6	38.4	74.9	348.2	58.7	52.00	2.58
7-C-8	41.7	64.6	3.2	52.3	72.66	2.78
7-C-10	14.3	69.1	345.4	49.9	48.16	1.75

DEMAGNETIZATION LEVEL = 410 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
7-C-6	181.6	66.1	249.7	72.2	25.62	1.29
7-C-8	110.2	60.9	47.6	75.6	32.52	1.27

DEMAGNETIZATION LEVEL = 555 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
7-A-1	25.4	48.4	6.1	34.4	15.76	.63
7-A-1P	16.1	29.3	7.7	14.5	28.93	1.13
7-A-2-1	312.2	30.0	310.5	5.7	14.94	.60
7-A-2-2	79.7	1.8	71.9	14.2	8.47	.43
7-A-3	147.6	30.3	150.6	56.0	15.60	.58
7-A-4	8.1	30.1	.8	13.0	121.08	4.34
7-A-5	358.2	37.0	350.5	17.2	162.83	7.03
7-A-6	1.8	30.1	355.5	11.4	235.98	8.78
7-A-7	359.6	33.3	352.8	14.0	243.23	8.88
7-A-7P	2.0	35.1	354.2	16.2	216.57	7.67
7-B-2-1	352.0	46.0	343.0	24.8	37.83	1.30
7-B-2-2	8.6	42.0	357.0	24.3	31.41	1.27
7-B-4	24.2	52.3	3.1	37.5	27.39	.99
7-B-6	18.8	46.6	2.4	31.0	36.80	1.30
7-B-8	3.7	41.7	353.4	22.9	37.82	1.84
7-B-10	175.1	11.2	181.3	30.2	28.41	1.00
7-C-2	228.1	73.1	279.5	60.5	14.90	.62
7-C-4	19.7	61.0	354.6	44.0	32.44	1.17
7-C-6	178.0	20.6	188.0	38.1	29.80	1.50
7-C-8	155.7	19.9	160.3	44.2	26.81	1.05
7-C-10	173.6	17.7	181.9	37.0	27.81	1.02

DEMAGNETIZATION LEVEL = 625 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
7-A-1	101.8	30.8	81.3	48.8	11.95	.48
7-A-1P	113.3	53.9	70.8	72.8	6.02	.24
7-A-2-1	279.1	25.0	278.7	5.2	15.70	.63
7-A-2-2	201.5	-15.7	197.1	-3.9	11.97	.62
7-A-3	165.8	14.5	171.6	36.3	18.80	.70
7-A-4	.9	30.7	354.6	11.8	37.73	1.36
7-A-5	350.5	37.2	344.1	15.9	84.44	3.66
7-A-6	5.1	30.6	358.2	12.7	110.22	4.12
7-A-7	359.0	36.1	351.4	16.5	136.42	5.01
7-A-7P	1.5	39.6	352.4	20.4	91.25	3.24
7-B-2-1	307.2	39.5	306.8	15.7	24.23	.83
7-B-2-2	291.5	60.3	299.2	37.9	20.22	.82
7-B-4	81.6	76.9	350.9	68.8	11.80	.43
7-B-6	229.3	49.1	251.4	42.3	14.70	.52
7-B-8	3.3	51.6	349.3	32.0	28.56	1.40
7-B-10	169.3	7.6	173.7	28.5	26.83	.94
7-C-2	193.4	33.0	210.7	43.2	9.67	.41
7-C-4	287.8	72.3	302.4	49.8	18.74	.68
7-C-6	178.6	9.8	184.5	27.6	32.61	1.65
7-C-8	163.0	10.0	167.1	32.6	34.44	1.35
7-C-10	192.2	2.2	195.3	15.7	30.52	1.12

APPENDIX 7

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
7-A-1	NRM	N	.1	33.0	353.3	13.8	1.00	3.484
7-A-1	555	N	25.4	48.4	6.1	34.4	.18	.626
7-A-1	625	M	101.8	30.8	81.3	48.8	.14	.476
7-A-1P	NRM	N	14.9	32.9	5.4	17.5	1.00	4.924
7-A-1P	555	N	16.1	29.3	7.7	14.5	.23	1.128
7-A-1P	625	M	113.3	53.9	70.8	72.8	.05	.236
7-A-2-1	NRM	N	355.2	46.2	345.3	25.5	1.00	2.737
7-A-2-1	555	M	312.2	30.0	310.5	5.7	.22	.598
7-A-2-1	625	M	279.1	25.0	278.7	5.2	.23	.632
7-A-2-2	NRM	N	2.9	41.2	353.0	22.2	1.00	2.973
7-A-2-2	555	M	79.7	1.8	71.9	14.2	.15	.434
7-A-2-2	625	R	201.5	-15.7	197.1	-3.9	.21	.618
7-A-3	NRM	N	22.2	48.2	4.1	33.3	1.00	2.004
7-A-3	555	M	147.6	30.3	150.6	56.0	.29	.579
7-A-3	625	M	165.8	14.5	171.6	36.3	.35	.700

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
7-A-4	NRM	N	359.6	37.6	351.5	18.0	1.00	10.404
7-A-4	555	N	8.1	30.1	.8	13.0	.42	4.342
7-A-4	625	N	.9	30.7	354.6	11.8	.13	1.358
7-A-5	NRM	N	355.3	39.1	347.5	18.7	1.00	14.245
7-A-5	555	N	358.2	37.0	350.5	17.2	.49	7.029
7-A-5	625	N	350.5	37.2	344.1	15.9	.25	3.656
7-A-6	NRM	N	354.8	34.3	348.5	13.9	1.00	18.339
7-A-6	555	N	1.8	30.1	355.5	11.4	.47	8.776
7-A-6	625	N	5.1	30.6	358.2	12.7	.22	4.120
7-A-7	NRM	N	354.1	36.8	347.2	16.2	1.00	20.845
7-A-7	555	N	359.6	33.3	352.8	14.0	.42	8.881
7-A-7	625	N	359.0	36.1	351.4	16.5	.24	5.010
7-A-7P	NRM	N	358.8	38.6	350.5	18.9	1.00	21.063
7-A-7P	555	N	2.0	35.1	354.2	16.2	.36	7.669
7-A-7P	625	N	1.5	39.6	352.4	20.4	.15	3.241

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
7-B-2-1	NRM	N	8.4	36.7	358.8	19.2	1.00	4.053
7-B-2-1	555	N	352.0	46.0	343.0	24.8	.32	1.298
7-B-2-1	625	M	307.2	39.5	306.8	15.7	.20	.835
7-B-2-2	NRM	N	9.7	41.3	358.1	23.8	1.00	4.282
7-B-2-2	555	N	8.6	42.0	357.0	24.3	.29	1.268
7-B-2-2	625	M	291.5	60.3	299.2	37.9	.19	.819
7-B-4	NRM	N	12.4	49.8	356.4	32.3	1.00	4.072
7-B-4	555	N	24.2	52.3	3.1	37.5	.24	.992
7-B-4	625	M	81.6	76.9	350.9	68.8	.10	.430
7-B-6	NRM	N	9.7	40.5	358.4	23.1	1.00	4.886
7-B-6	555	N	18.8	46.6	2.4	31.0	.26	1.296
7-B-6	625	M	229.3	49.1	251.4	42.3	.11	.519
7-B-8	NRM	N	1.2	41.9	351.4	22.5	1.00	5.010
7-B-8	555	N	3.7	41.7	353.4	22.9	.36	1.843
7-B-8	625	N	3.3	51.6	349.3	32.0	.27	1.399

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
7-B-10	NRM	M	73.4	67.5	12.5	63.9	1.00	1.521
7-B-10	555	M	175.1	11.2	181.3	30.2	.65	.998
7-B-10	625	M	169.3	7.6	173.7	28.5	.62	.945
7-C-2	NRM	N	16.3	56.3	355.5	39.1	1.00	2.655
7-C-2	555	M	228.1	73.1	279.5	60.5	.23	.621
7-C-2	625	M	193.4	33.0	210.7	43.2	.15	.406
7-C-4	NRM	N	8.6	47.0	354.9	28.9	1.00	4.340
7-C-4	555	N	19.7	61.0	354.6	44.0	.27	1.166
7-C-4	625	M	287.8	72.3	302.4	49.8	.15	.680
7-C-6	NRM	N	38.4	74.9	348.2	58.7	1.00	2.577
7-C-6	410	M	181.6	66.1	249.7	72.2	.49	1.288
7-C-6	555	M	178.0	20.6	188.0	38.1	.57	1.502
7-C-6	625	M	178.6	9.8	184.5	27.6	.63	1.652

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
7-C-8	NRM	N	41.7	64.6	3.2	52.3	1.00	2.780
7-C-8	410	M	110.2	60.9	47.6	75.6	.45	1.267
7-C-8	555	M	155.7	19.9	160.3	44.2	.37	1.046
7-C-8	625	M	153.0	10.0	167.1	32.6	.47	1.350
7-C-10	NRM	N	14.3	69.1	345.4	49.9	1.00	1.748
7-C-10	555	M	173.6	17.7	181.9	37.0	.58	1.019
7-C-10	625	M	192.2	2.2	195.3	15.7	.63	1.124

APPENDIX 8

DEMAGNETIZATION LEVEL = NRM

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
24-9	340.7	42.0	353.7	30.4	33.07	1.40
24-8	21.8	-13.8	19.1	-33.2	12.79	.52
24-7-2	81.4	62.4	71.9	45.6	29.89	1.43
24-7-1	319.3	80.5	19.0	66.7	39.19	1.68
24-6	28.8	59.6	35.6	41.0	19.93	.89
24-5-2	326.5	35.4	340.0	28.0	30.25	1.21
24-5-1	37.4	65.8	42.1	46.8	63.78	2.85
24-4	42.7	67.7	45.5	48.6	52.28	2.21
24-3	339.4	56.7	360.0	44.2	50.01	2.15
24-2	248.7	9.3	258.3	28.2	108.89	5.27

DEMAGNETIZATION LEVEL = 423 DEGREES C

SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
24-9	331.9	38.6	345.5	29.4	22.62	.96
24-8	8.7	-42.0	352.0	-57.1	12.73	.52
24-7-2	277.6	4.8	287.3	16.1	60.94	2.92
24-7-1	227.2	75.4	32.4	83.5	26.41	1.13
24-6	51.2	71.5	50.2	52.4	6.12	.27
24-5-2	326.2	32.2	338.3	25.1	25.92	1.04
24-5-1	33.1	72.2	40.3	53.1	47.58	2.13
24-4	21.8	60.1	30.7	41.9	40.44	1.71
24-3	331.7	60.6	357.6	49.3	34.53	1.49
24-2	246.1	9.1	255.2	28.5	76.95	3.80

DEMAGNETIZATION LEVEL = 560 DEGREES C

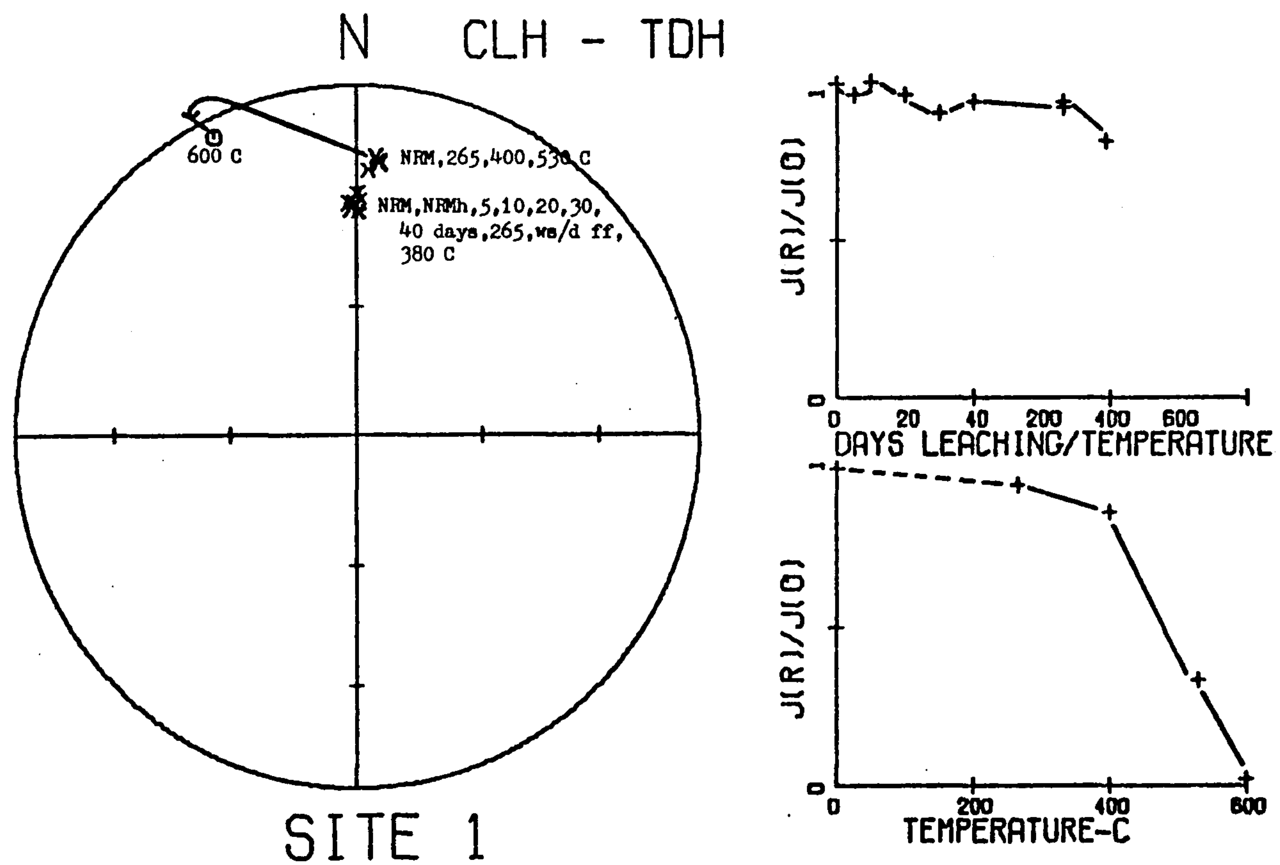
SAMPLE NO.	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY J(E-6 EMU)	J(E-6 EMU/GR)
24-9	352.6	53.9	7.7	39.2	14.04	.60
24-8	346.3	-33.5	332.8	-41.1	11.18	.46
24-7-2	234.3	55.0	256.6	75.4	3.87	.19
24-7-1	187.6	58.1	152.4	70.7	15.02	.65
24-6	96.9	24.9	97.9	11.6	8.41	.38
24-5-2	326.5	12.2	331.7	7.2	25.14	1.01
24-5-1	51.1	58.5	51.8	39.7	32.91	1.48
24-4	21.4	57.5	29.9	39.3	33.74	1.43
24-3	18.9	65.4	30.2	47.1	24.29	1.05
24-2	249.4	11.3	259.6	30.0	67.77	3.38

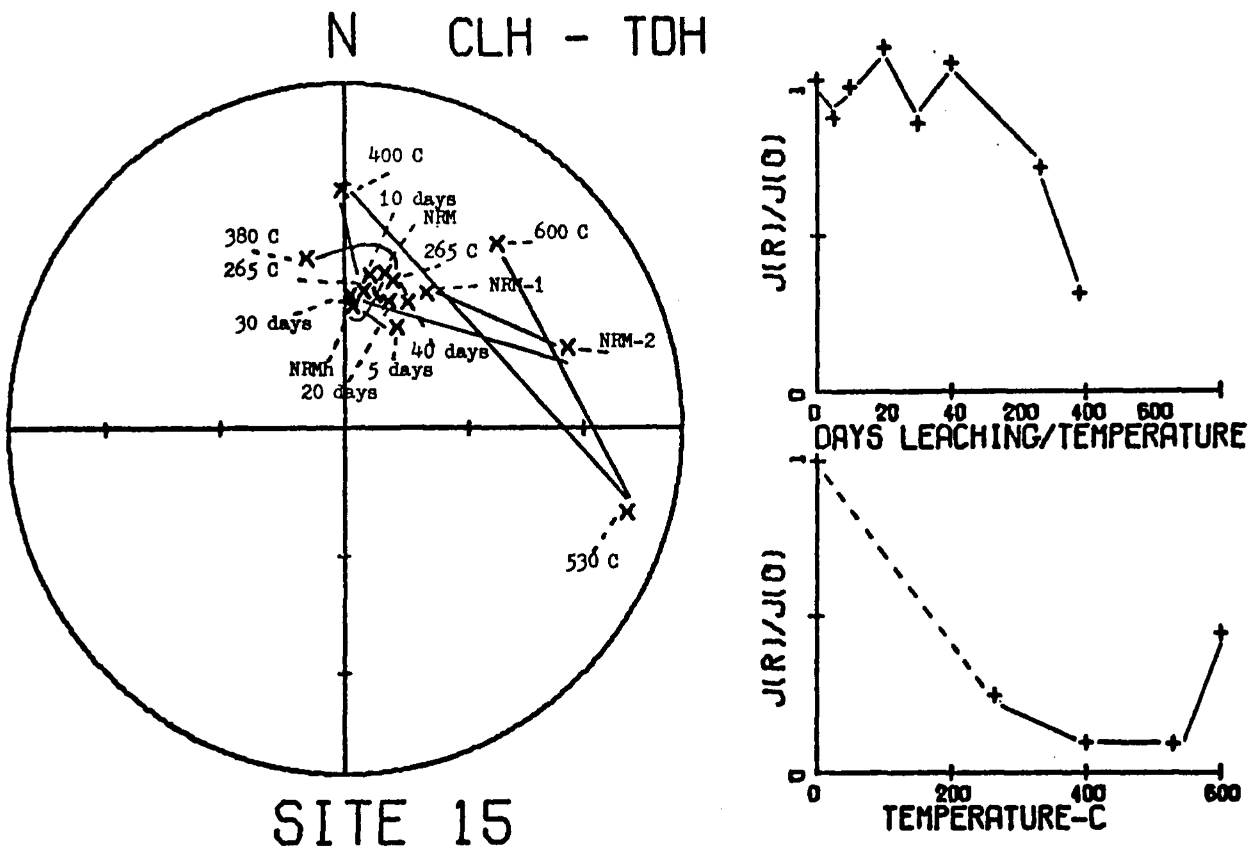
APPENDIX 9

SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
24-9	NRM	N	340.7	42.0	353.7	30.4	1.00	1.399
24-9	423	N	331.9	38.6	345.5	29.4	.68	.960
24-9	560	N	352.6	53.9	7.7	39.2	.42	.597
24-8	NRM	M	21.8	-13.8	19.1	-33.2	1.00	.524
24-8	423	M	8.7	-42.0	352.0	-57.1	.99	.523
24-8	560	M	346.3	-33.5	332.8	-41.1	.87	.461
24-7-2	NRM	M	81.4	62.4	71.9	45.6	1.00	1.430
24-7-2	423	M	277.6	4.8	287.3	16.1	2.04	2.923
24-7-2	560	M	234.3	55.0	256.6	75.4	.13	.187
24-7-1	NRM	N	319.3	80.5	19.0	66.7	1.00	1.677
24-7-1	423	M	227.2	75.4	32.4	83.5	.67	1.133
24-7-1	560	M	187.6	58.1	152.4	70.7	.38	.648
24-6	NRM	N	28.8	59.6	35.6	41.0	1.00	.885
24-6	423	M	51.2	71.5	50.2	52.4	.31	.272
24-6	560	M	96.9	24.9	97.9	11.6	.42	.376

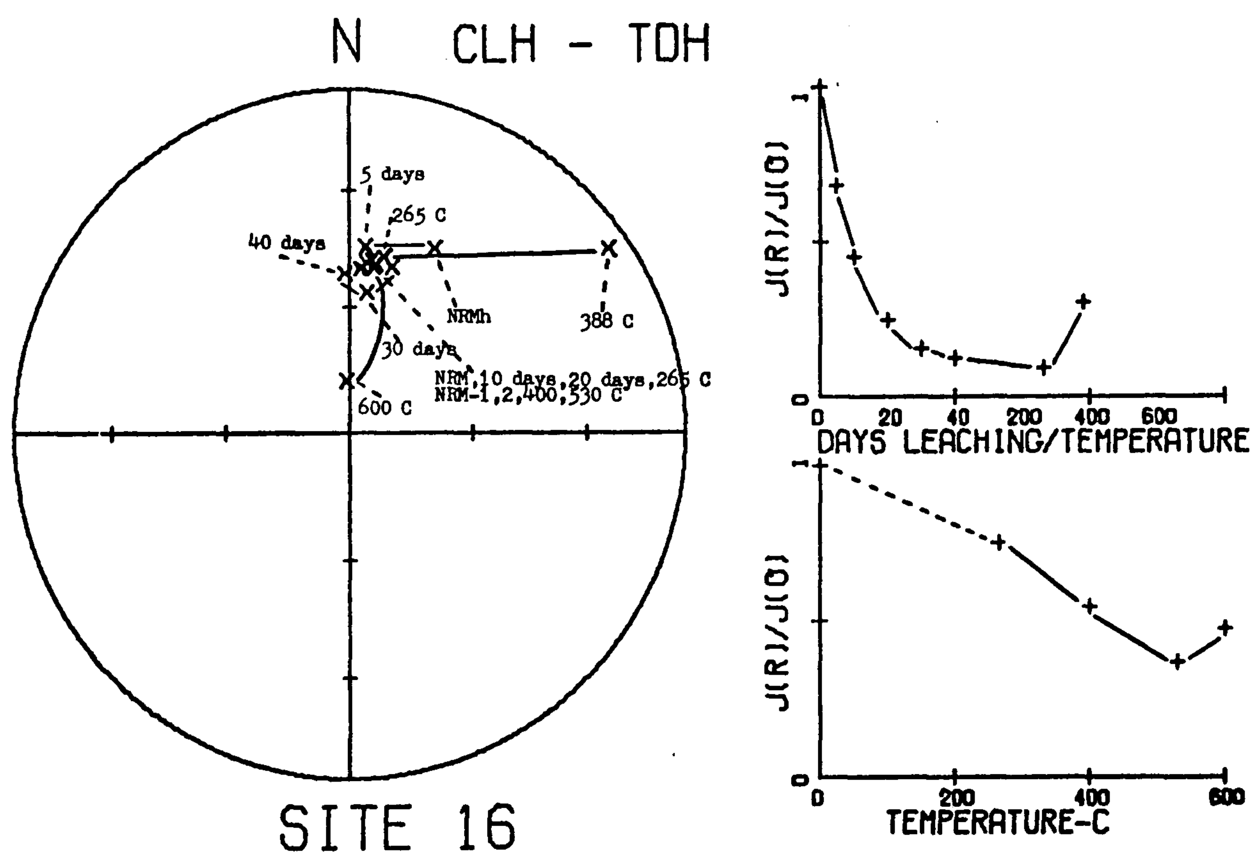
SAMPLE NO.	DEMAG LEVEL	POLARITY (N,R, OR M)	MAGNETIC DIRECTION DEC	INC	(CORRECTED) DEC	INC	INTENSITY RELATIVE J	J(E-6EMU/GR)
24-5-2	NRM	N	326.5	35.4	340.0	28.0	1.00	1.214
24-5-2	423	N	326.2	32.2	338.3	25.1	.86	1.041
24-5-2	560	N	326.5	12.2	331.7	7.2	.83	1.014
24-5-1	NRM	N	37.4	65.8	42.1	46.8	1.00	2.852
24-5-1	423	N	33.1	72.2	40.3	53.1	.75	2.131
24-5-1	560	M	51.1	58.5	51.8	39.7	.52	1.480
24-4	NRM	N	42.7	67.7	45.5	48.6	1.00	2.206
24-4	423	N	21.8	60.1	30.7	41.9	.77	1.709
24-4	560	N	21.4	57.5	29.9	39.3	.65	1.431
24-3	NRM	N	339.4	56.7	360.0	44.2	1.00	2.149
24-3	423	N	331.7	60.6	357.6	49.3	.69	1.487
24-3	560	N	18.9	65.4	30.2	47.1	.49	1.054
24-2	NRM	M	248.7	9.3	258.3	28.2	1.00	5.265
24-2	423	M	246.1	9.1	255.2	28.5	.71	3.801
24-2	560	M	249.4	11.3	259.6	30.0	.62	3.377

APPENDIX 10

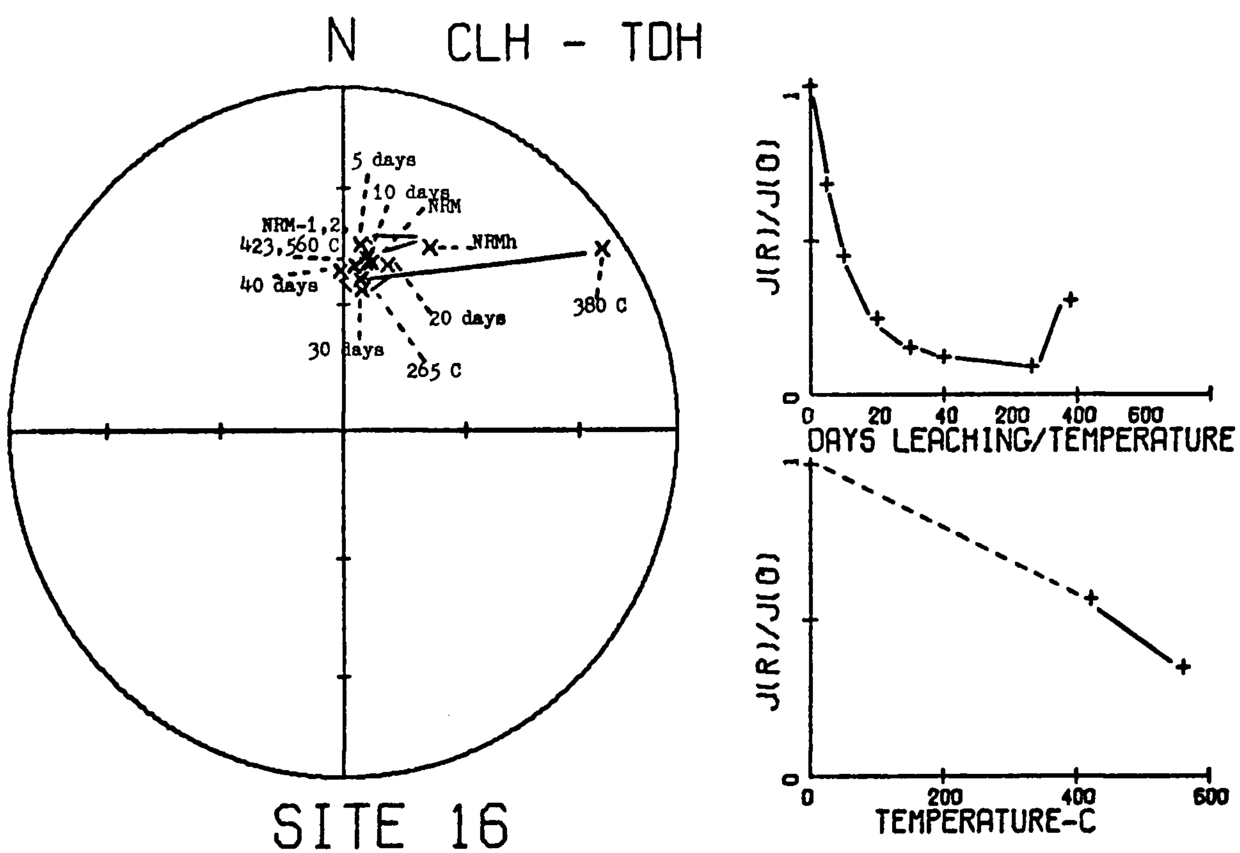

N CLH - TDH
600 C
NRM,265,400,530 C
NRM,NRMh,5,10,20,30,
40 days,265,ws/d ff,
380 C
SITE 1
J(R)/J(0)
DAYS LEACHING/TEMPERATURE
J(R)/J(0)
TEMPERATURE-C



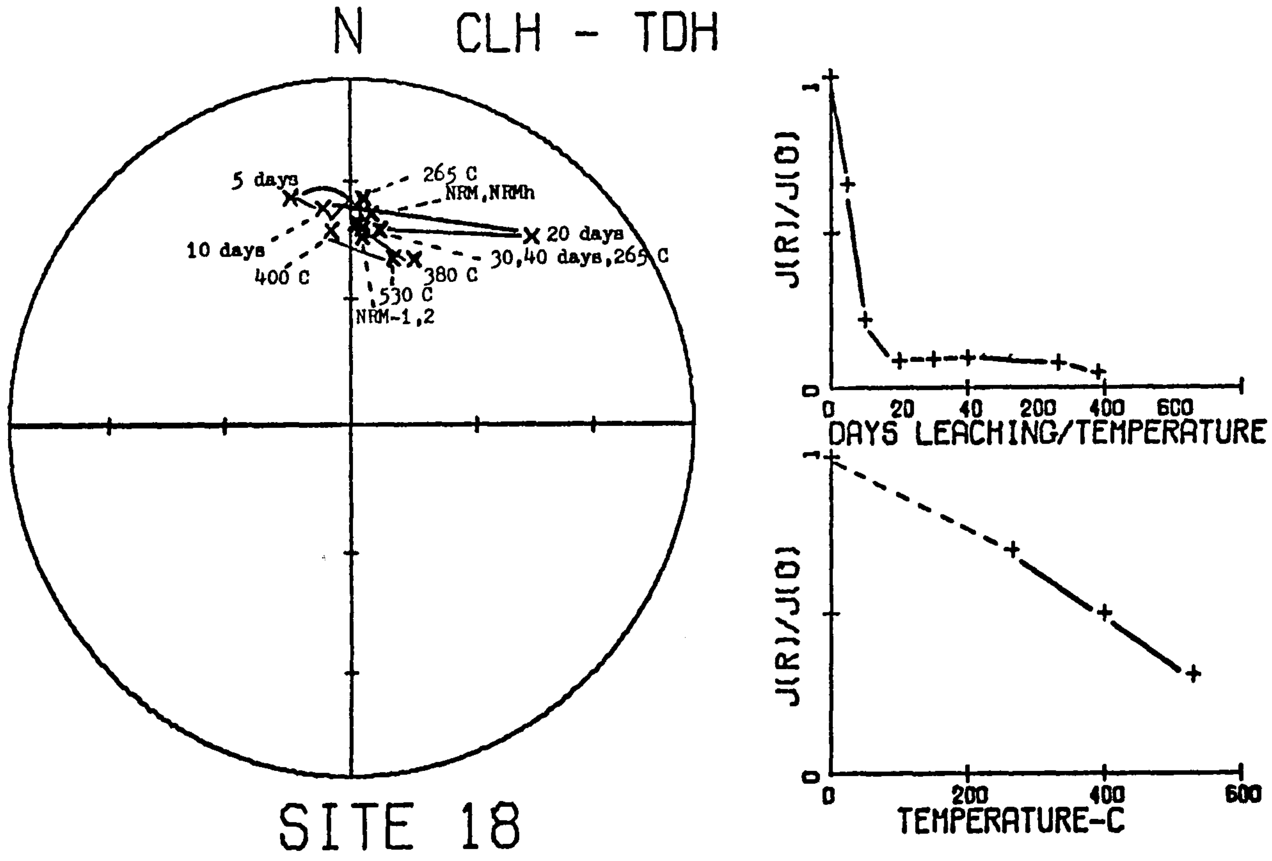
N
CLH - TDH
400 C
10 days
NRM
380 C
265 C
265 C
600 C
NRM-1
30 days
NRM-2
40 days
NRMh
5 days
20 days
530 C
SITE 15
J(R)/J(0)
DAYS LEACHING/TEMPERATURE
0
20
40
200
400
600
1
J(R)/J(0)
TEMPERATURE-C
0
200
400
600
1



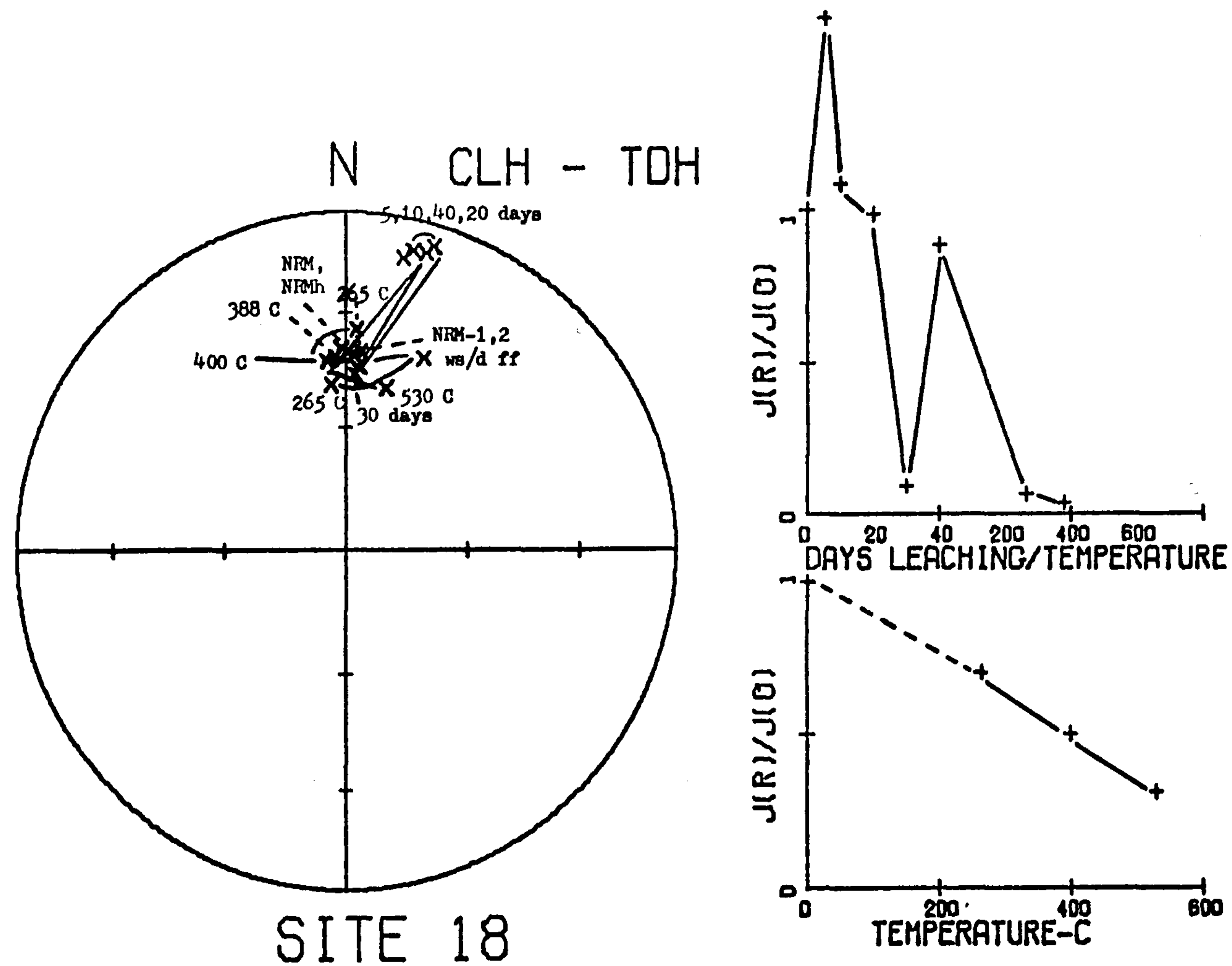
(Specimens 16-2-2, 16-2-1)



(Specimens 16-2-2, 16-2-1)

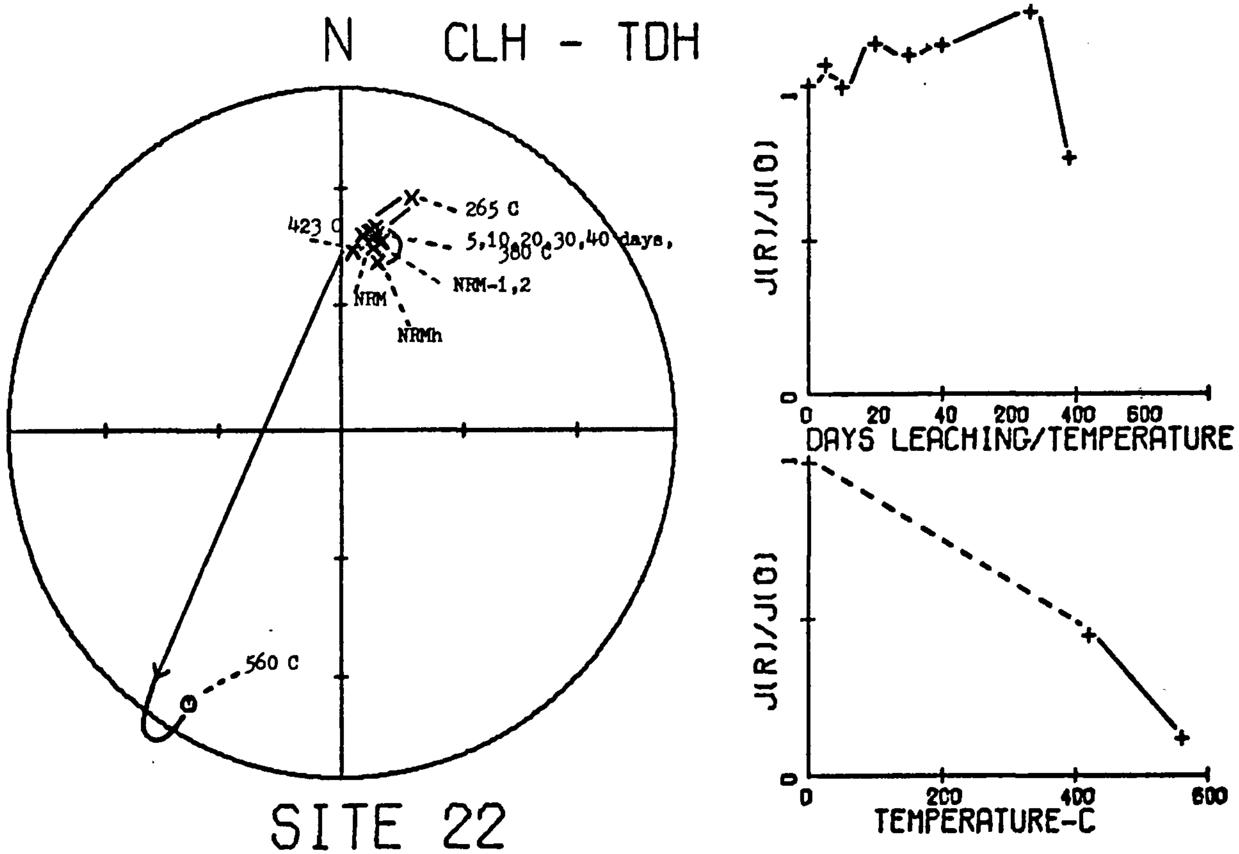


(Specimens 18-1-1, 18-1-2)

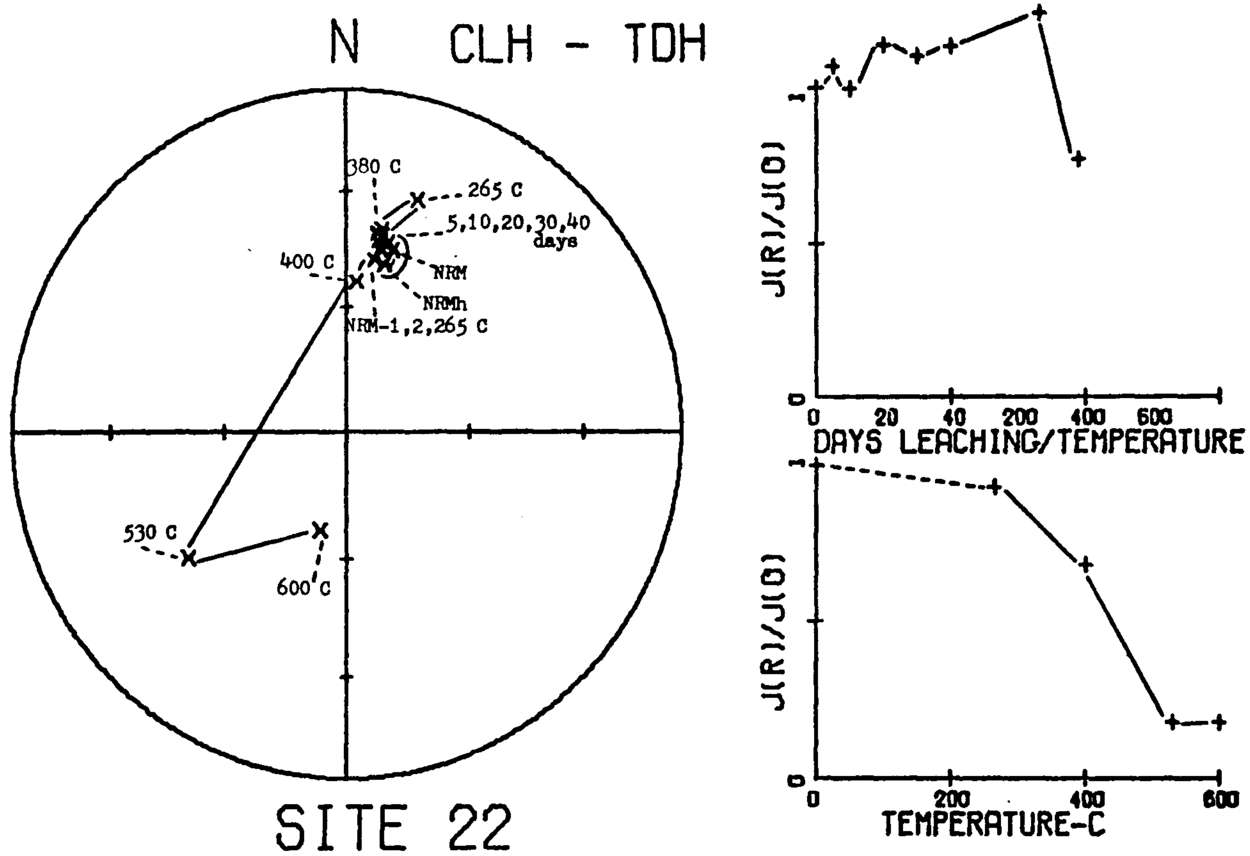


SITE 18

(Specimens 18-1-3, 18-1-4)

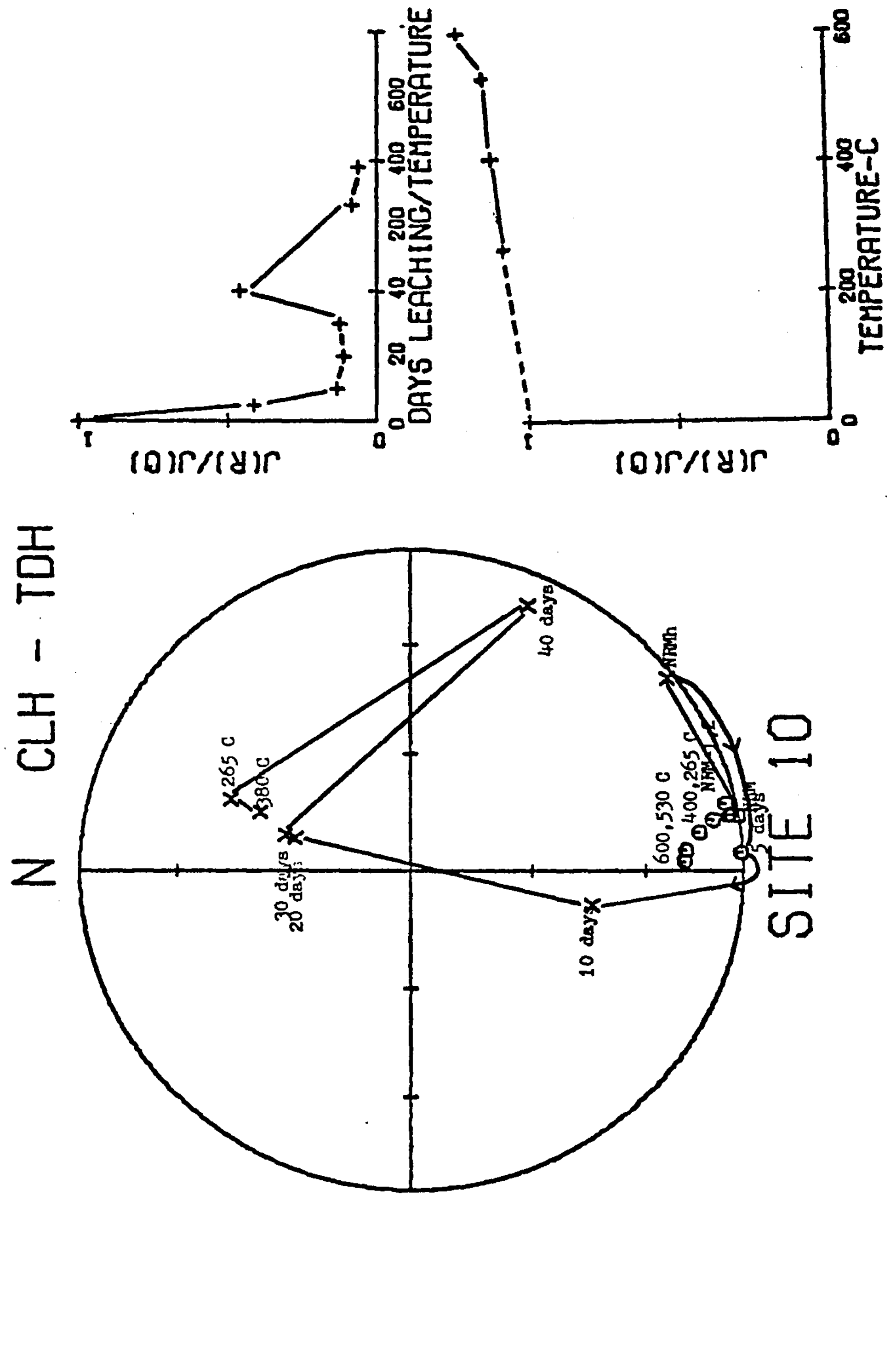


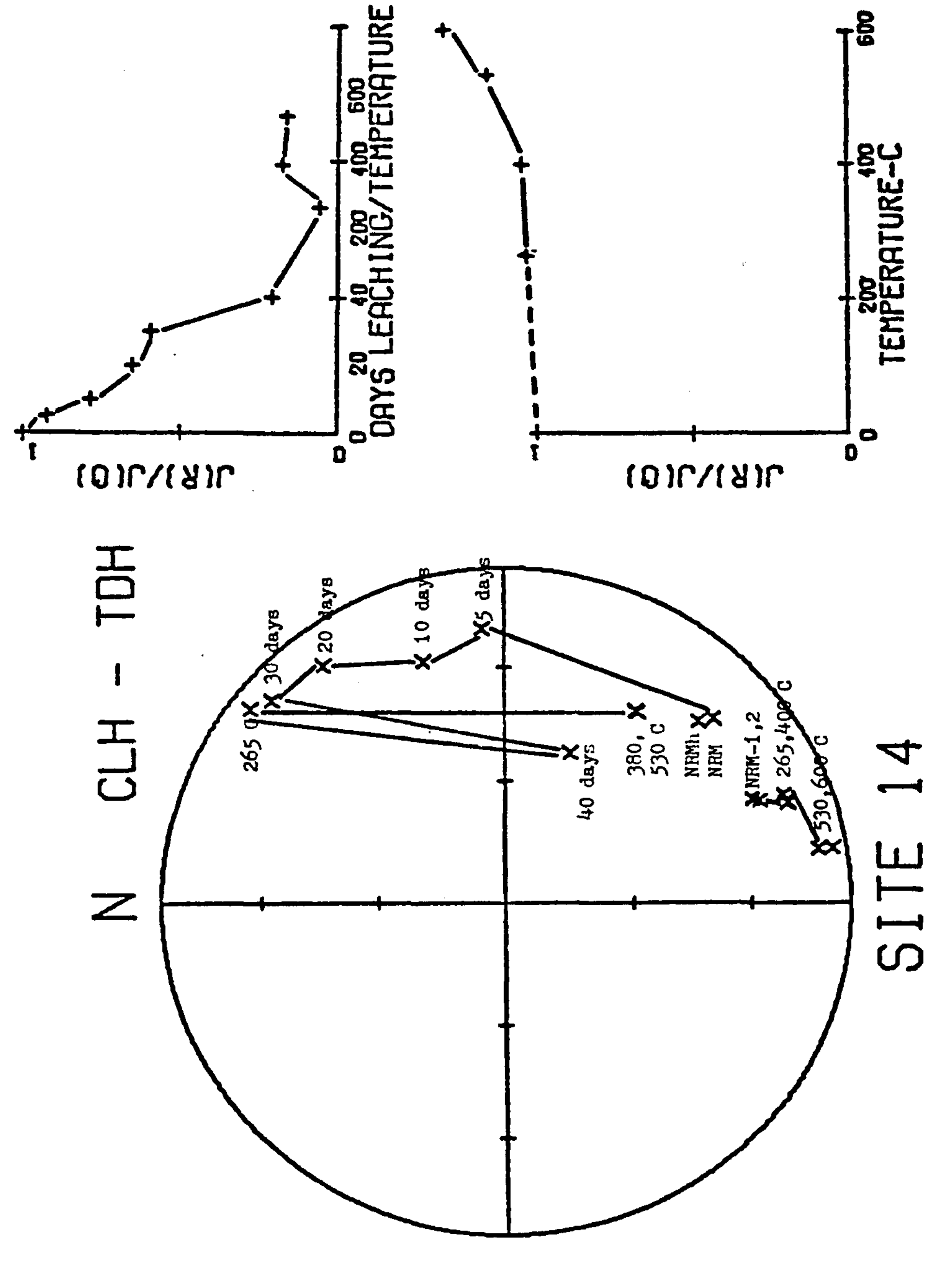
(Specimens 22-4-1, 22-4-2)



(Specimens 22-4-1, 22-4-3)

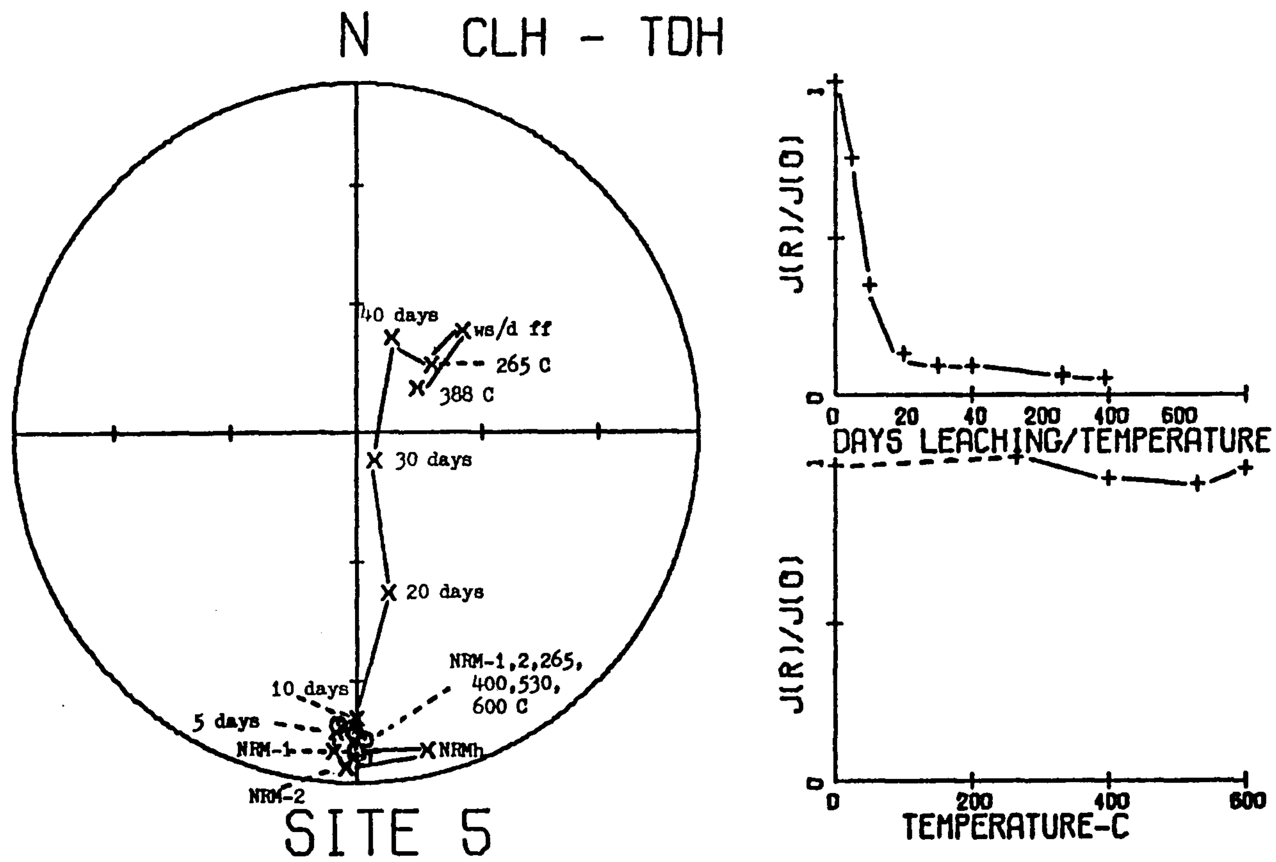
APPENDIX 11


N CLH - TDH
SITE 10
40 days
NRM
10 days
30 days
20 days
265 C
380 C
600,530 C
400,265 C
5 days
J(R)/J(0)
DAYS LEACHING/TEMPERATURE
TEMPERATURE-C



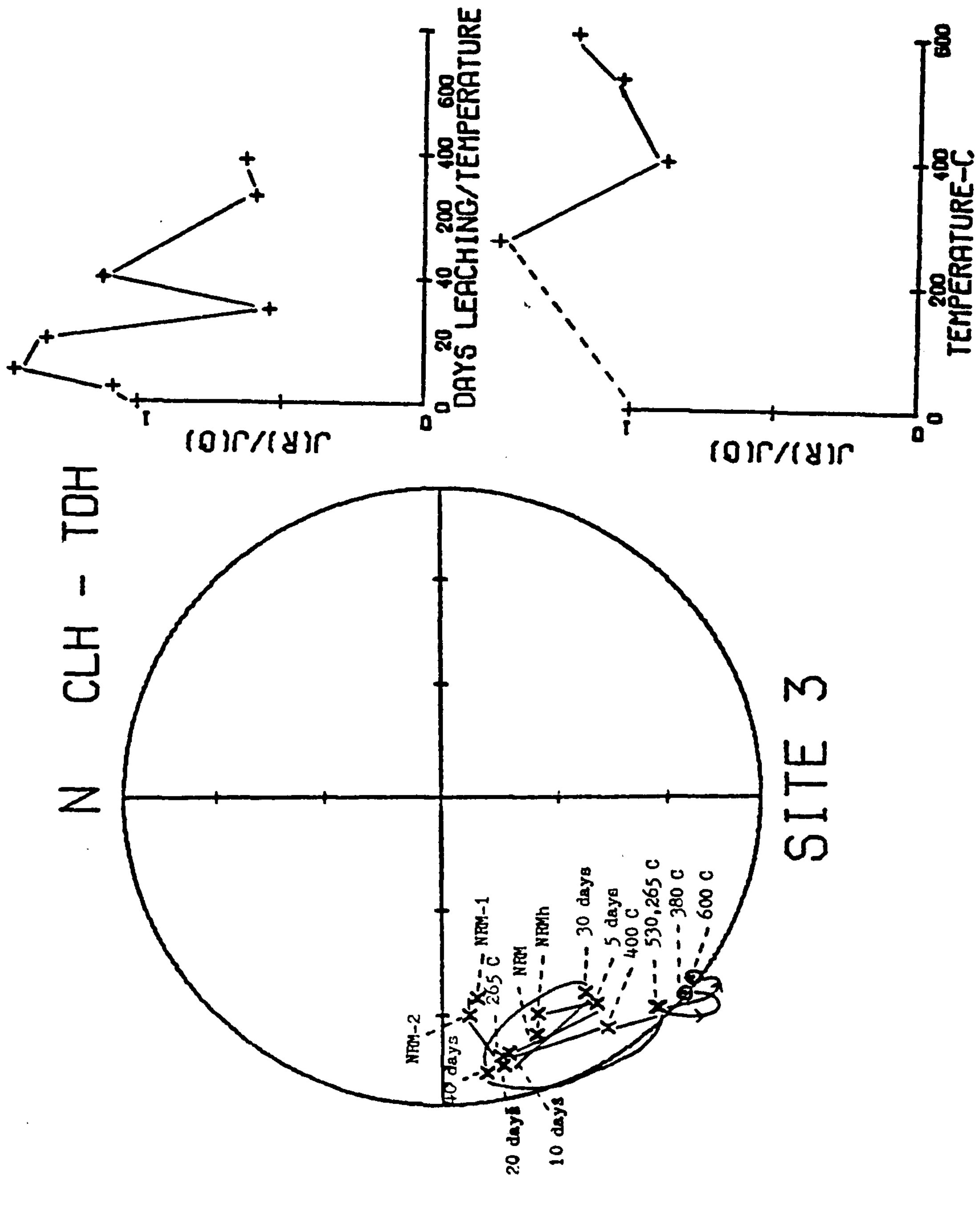
SITE 14
N CLH - TDH
5 days
10 days
20 days
30 days
40 days
265 C
380, 530 C
NRM
NRM-1,2
265,400 C
530,600 C
J(R)/J(0)
DAYS LEACHING/TEMPERATURE
TEMPERATURE-C

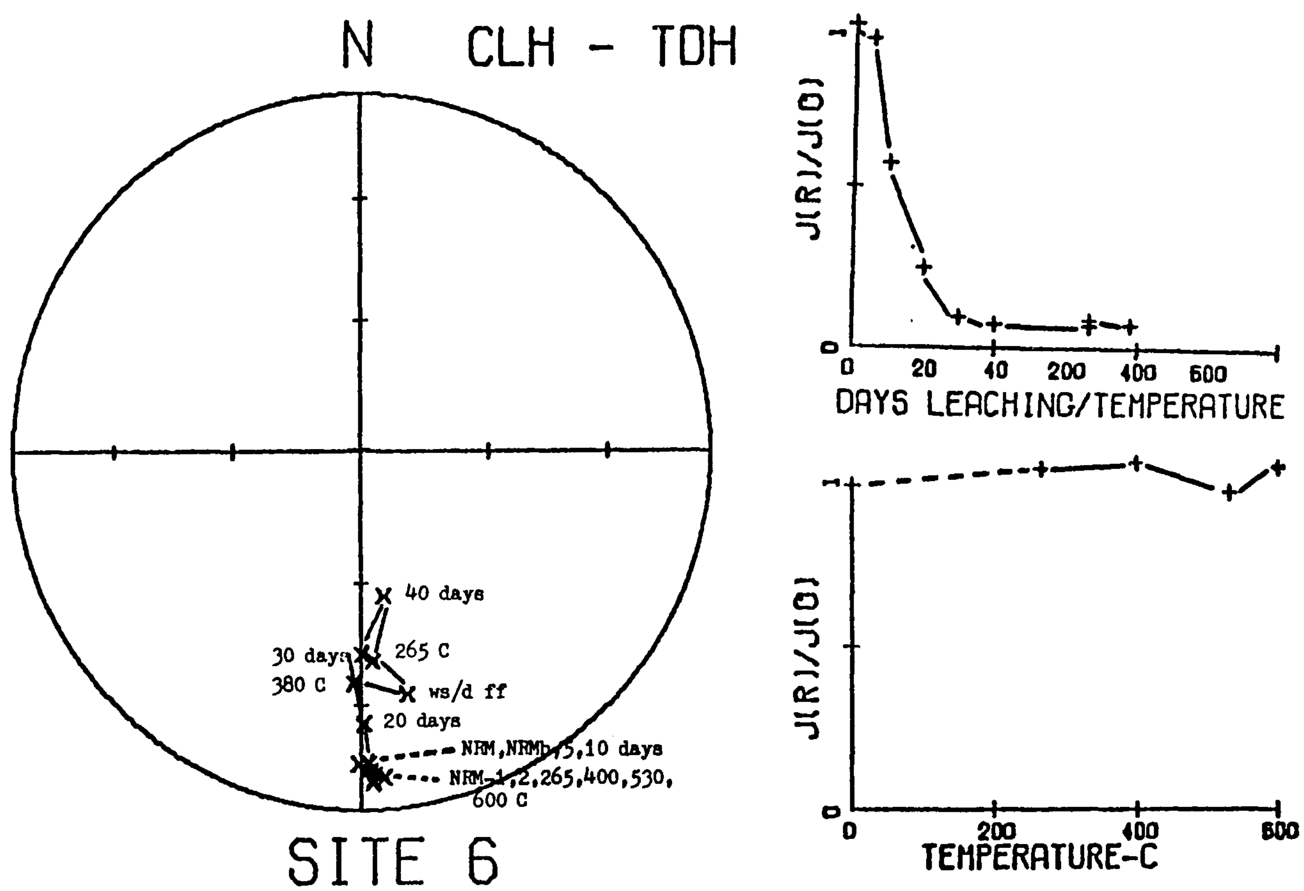
APPENDIX 12



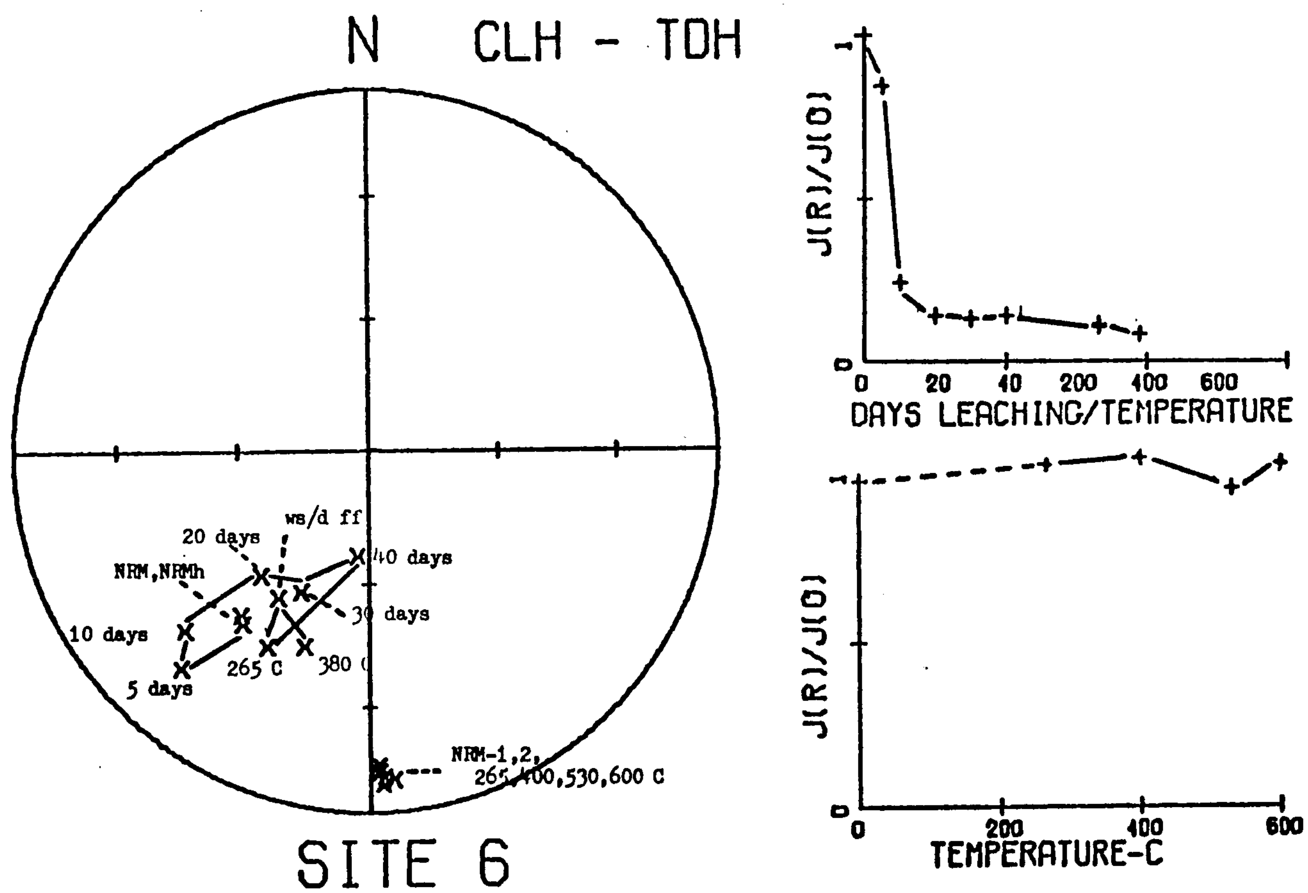
(Specimens 5-6-1, 5-6-3)

APPENDIX 13

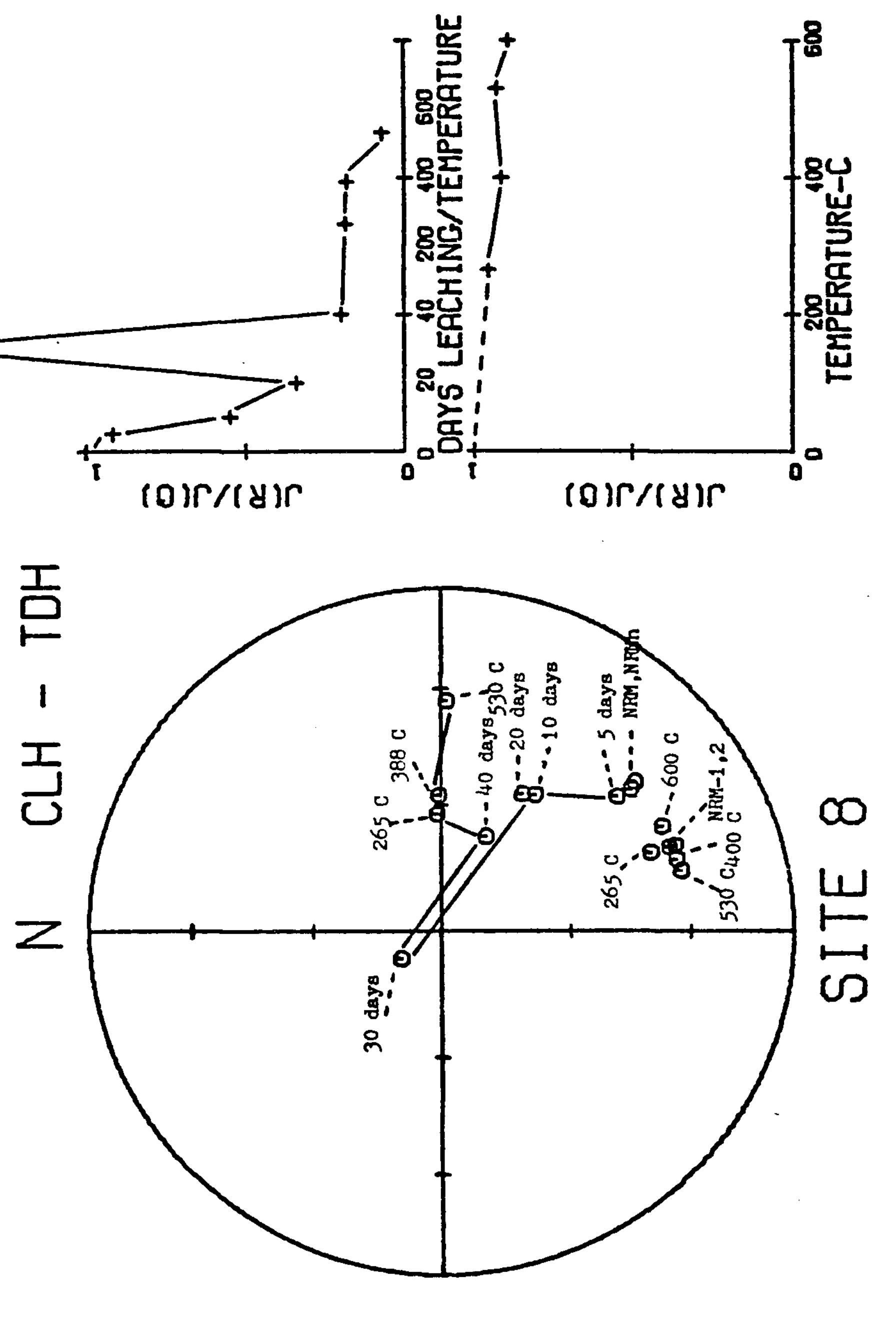

N
CLH - TDH
SITE 3
NRM-2
NRM-1
265 C
NRM
NRMh
30 days
5 days
400 C
530,265 C
380 C
600 C
40 days
20 days
10 days
J(R)/J(0)
DAYS LEACHING/TEMPERATURE
J(R)/J(0)
TEMPERATURE-C



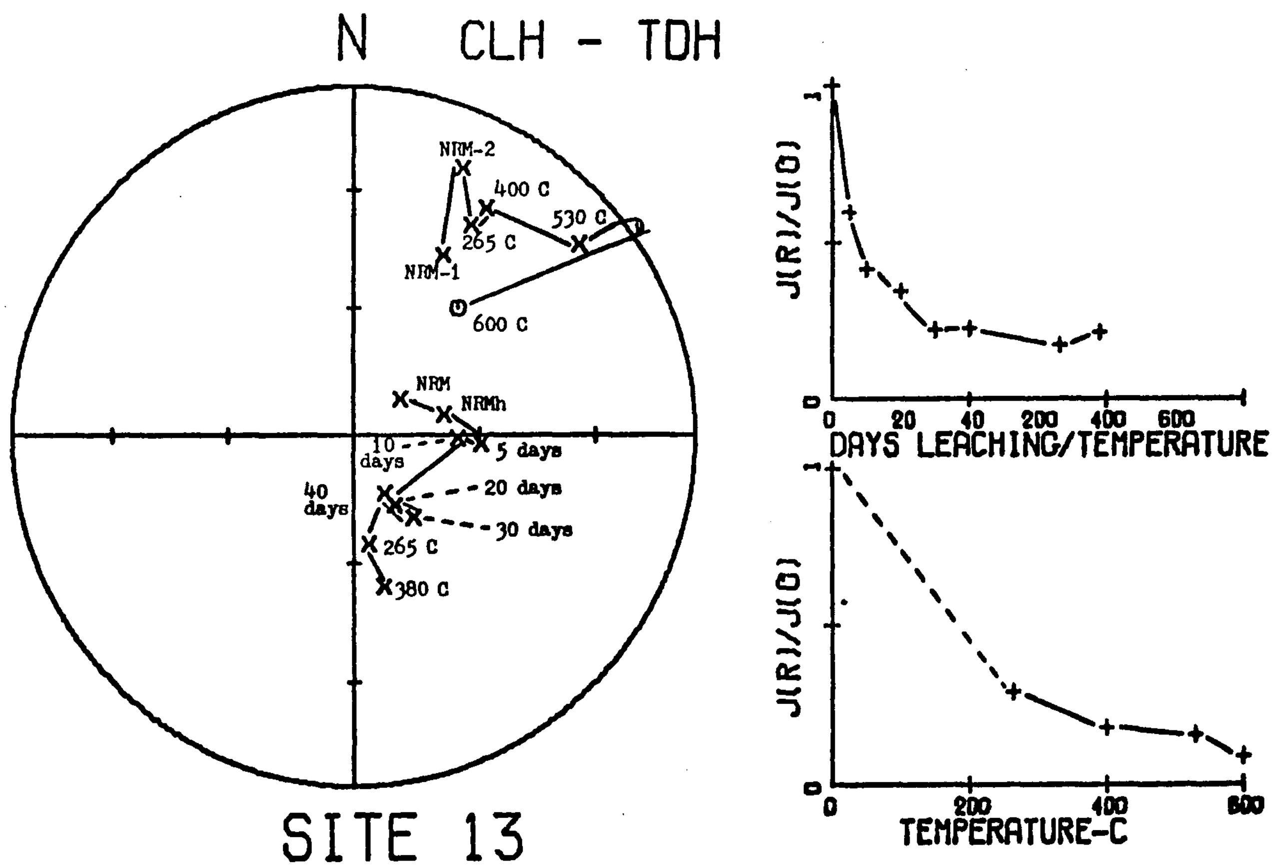
(Specimens 6-1-2, 6-1-1)

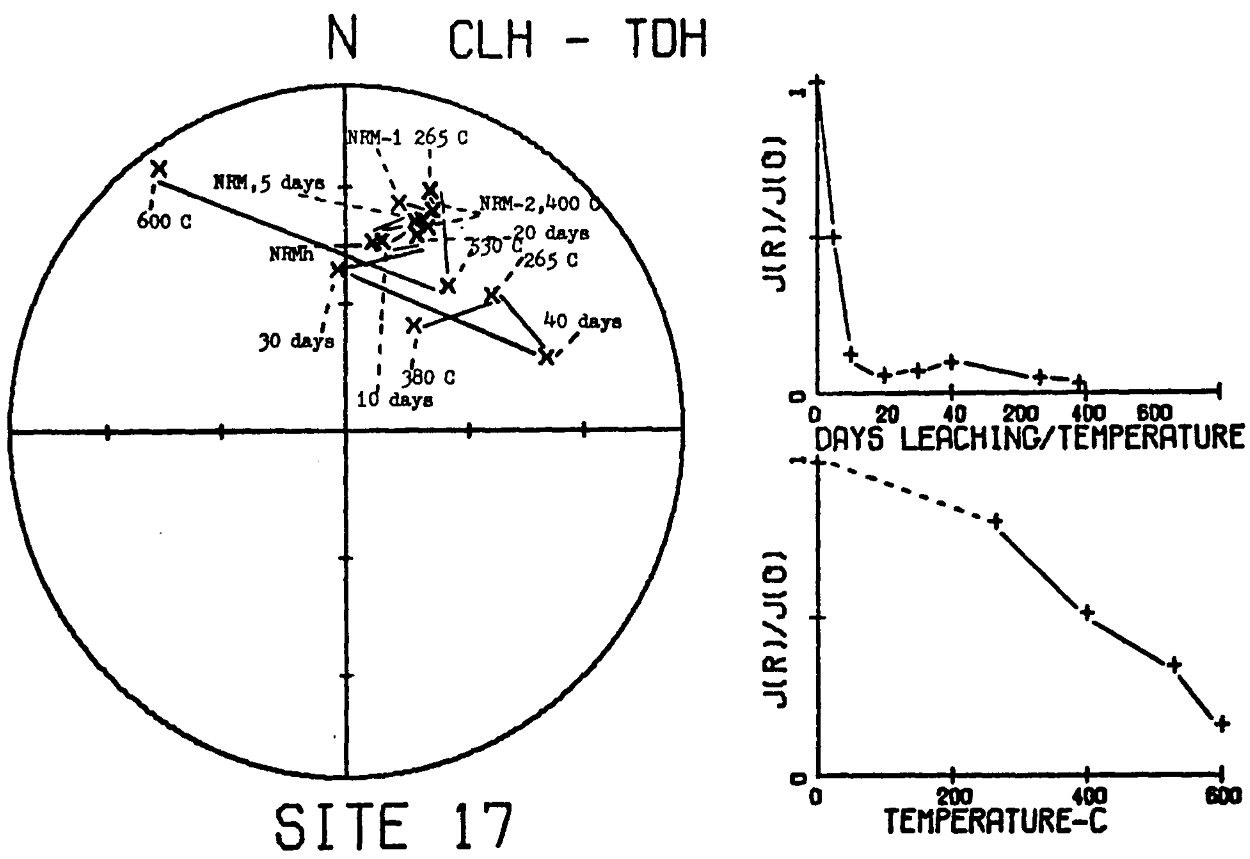


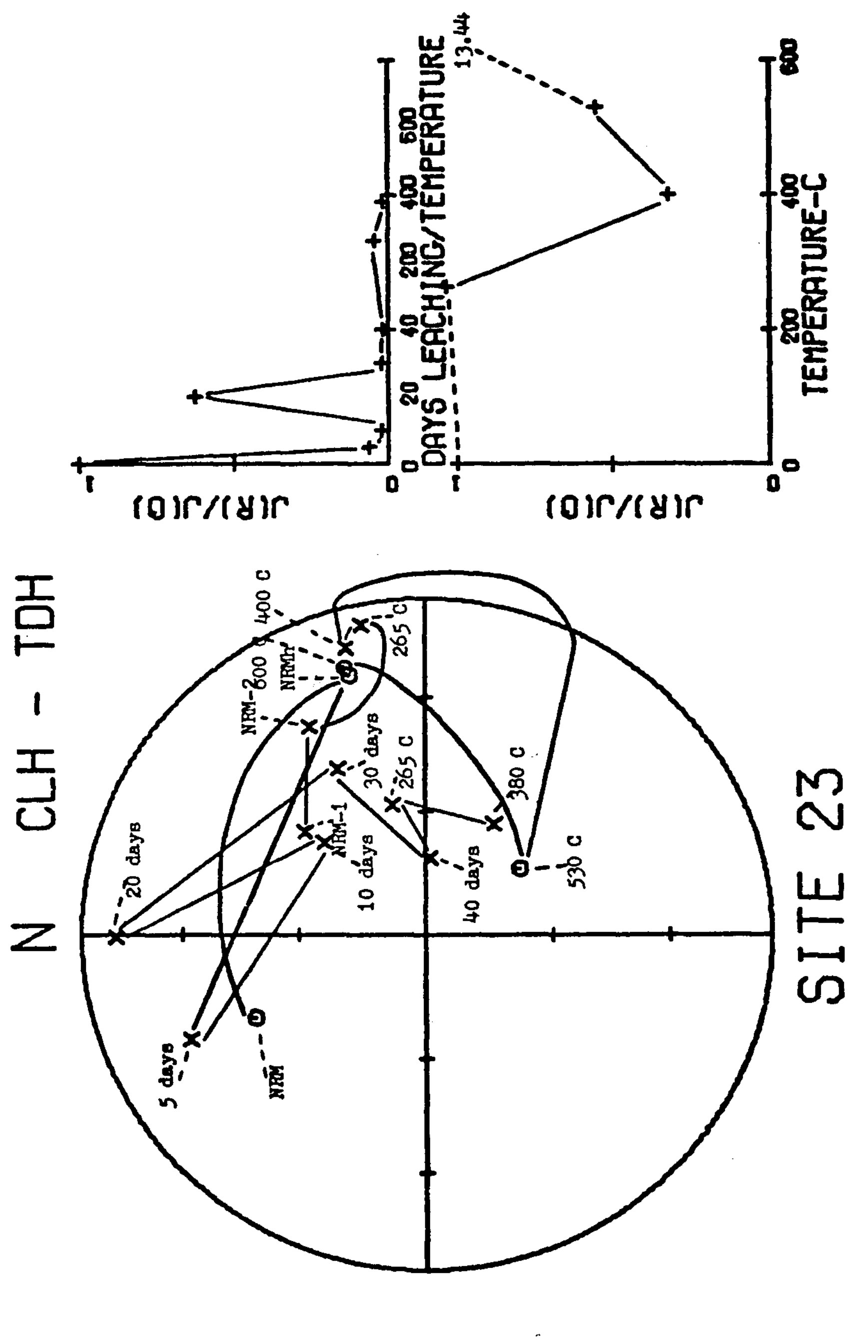
(Specimens 6-2-3, 6-1-1)



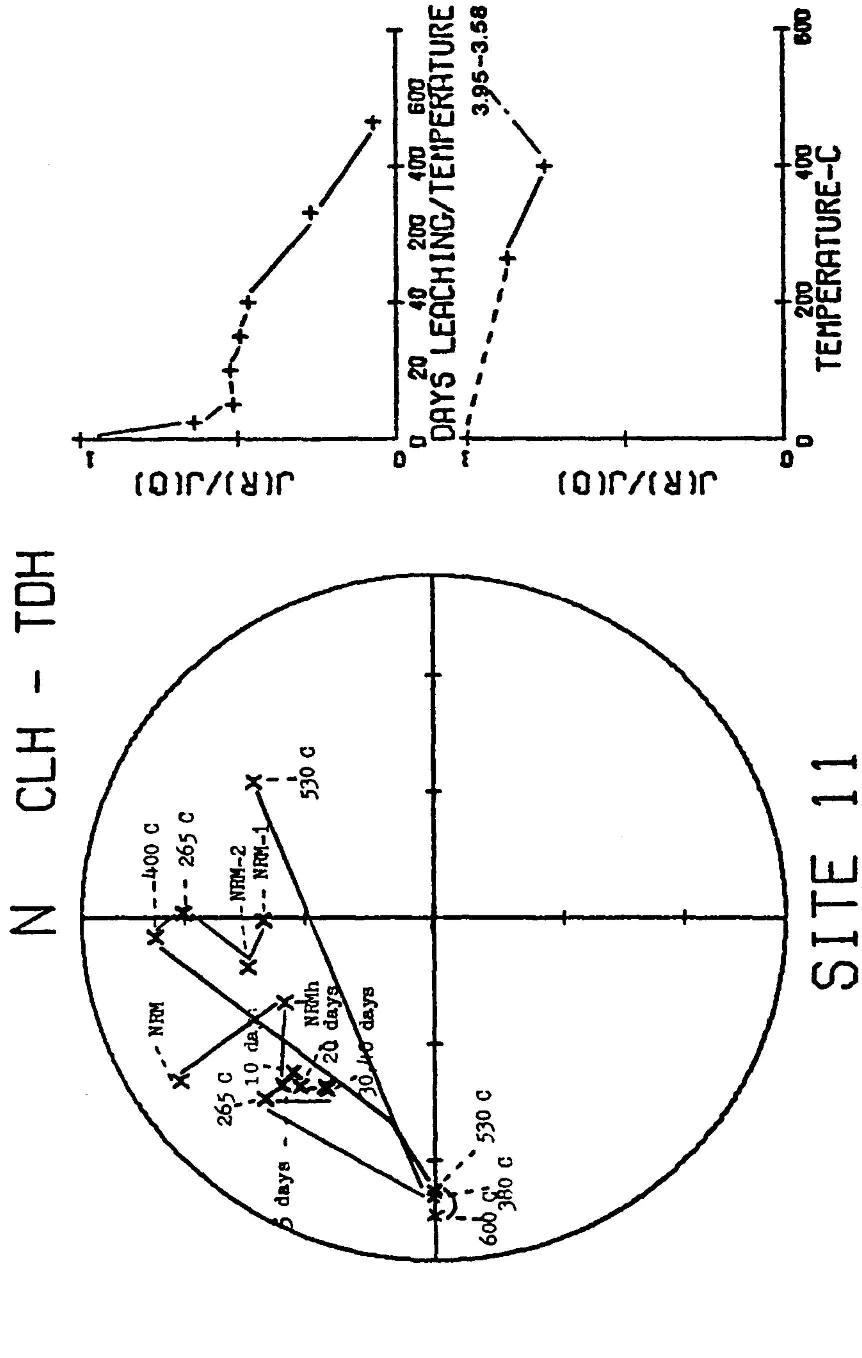
N
CLH - TDH
SITE 8
30 days
265 C
388 C
40 days
530 C
20 days
10 days
5 days
NRM,NRMn
600 C
NRM-1,2
400 C
J(R)/J(O)
DAYS LEACHING/TEMPERATURE
TEMPERATURE-C

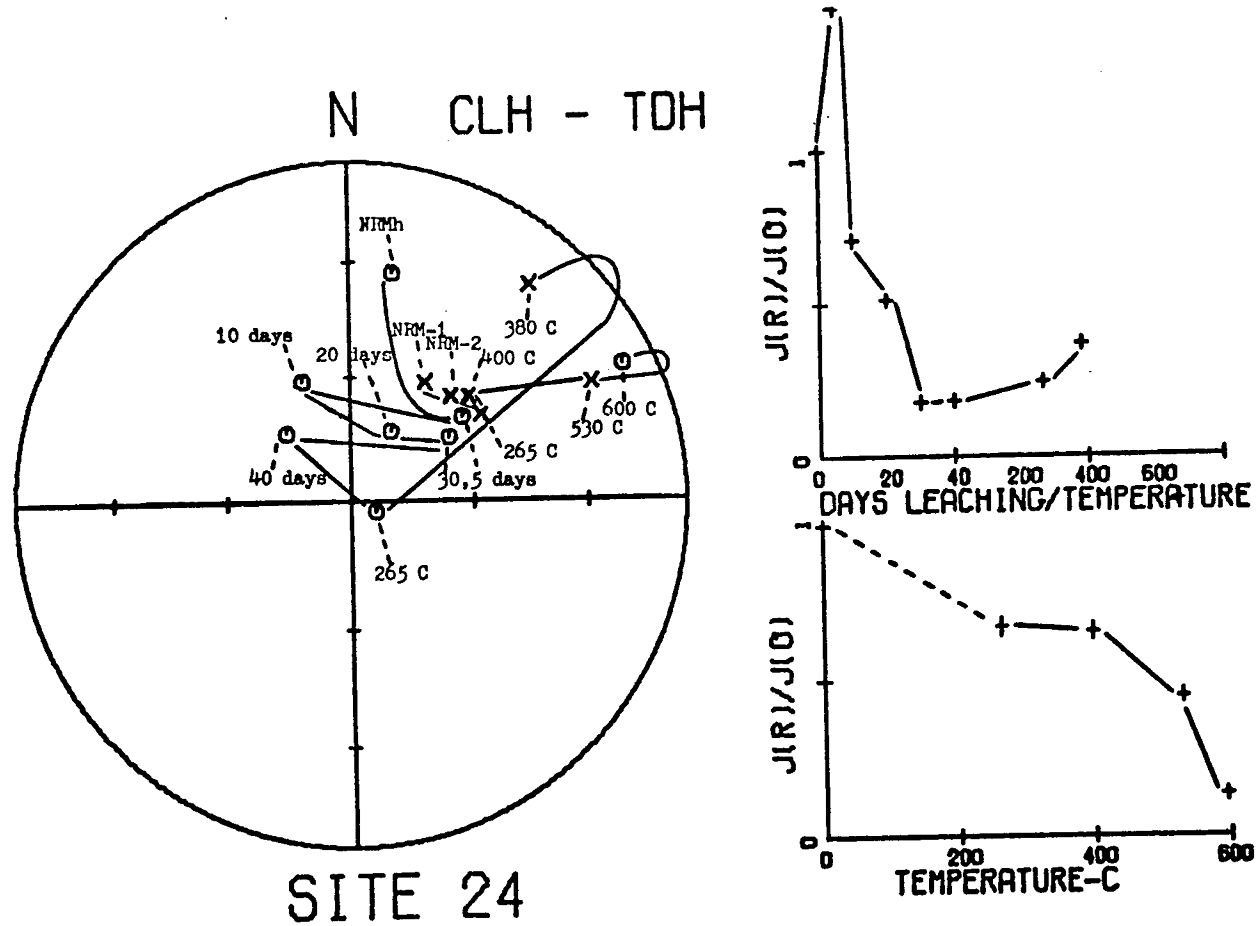

N
CLH - TDH
NRM-2
400 C
530 C
265 C
NRM-1
600 C
NRM
NRMh
10 days
5 days
40 days
20 days
30 days
265 C
380 C
SITE 13
J(R)/J(0)
DAYS LEACHING/TEMPERATURE
0
20
40
200
400
600
J(R)/J(0)
TEMPERATURE-C
1
0


N
CLH - TDH
NRM-1 265 C
NRM,5 days
NRM-2,400 C
20 days
330 C
265 C
600 C
NRMh
40 days
30 days
380 C
10 days
SITE 17
J(R)/J(O)
1
0
0
20
40
200
400
600
DAYS LEACHING/TEMPERATURE
J(R)/J(O)
1
0
0
200
400
600
TEMPERATURE-C


N
CLH - TDH
SITE 23
20 days
5 days
NRM
10 days
NRM-1
30 days
265 C
40 days
380 C
530 C
NRM-2
600 C
NRM-I
400 C
265 C
J(R)/J(O)
DAYS LEACHING/TEMPERATURE
TEMPERATURE-C
13.44

APPENDIX 14


N CLH - TDH
SITE 11
DAYS LEACHING/TEMPERATURE
TEMPERATURE-C
J(R)/J(0)
3.95-3.58


N
CLH - TDH
NRMh
NRM-1
NRM-2
10 days
20 days
40 days
30,5 days
380 C
400 C
265 C
530 C
600 C
265 C
SITE 24
J(R)/J(O)
DAYS LEACHING/TEMPERATURE
0
1
0
20
40
200
400
600
J(R)/J(O)
TEMPERATURE-C
0
1
0
200
400
600

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